

AQUATIC PLANT MANAGEMENT PLAN UPDATE FOR THE LAUDERDALE LAKES

WALWORTH COUNTY, WISCONSIN



GREEN
LAKE

MIDDLE
LAKE

MILL
LAKE

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**AQUATIC PLANT MANAGEMENT PLAN UPDATE
FOR THE LAUDERDALE LAKES WALWORTH COUNTY, WISCONSIN**

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Credit: Commission Staff

The Southeastern Wisconsin Planning Commission (Commission or SEWRPC) completed this aquatic plant inventory and management study of the Lauderdale Lakes on behalf of the Lauderdale Lakes Lake Management District (District). This memorandum report is the Commission's fourth aquatic plant management plan for the Lauderdale Lakes.^{1,2,3} The Wisconsin Department of Natural Resources (WDNR) will use data and conclusions generated as part of the Commission's study to evaluate the Lake's aquatic plant community and draft an updated Aquatic Plant Management Control permit.

1.1 PROJECT SETTING, BACKGROUND, SCOPE, AND INTENT

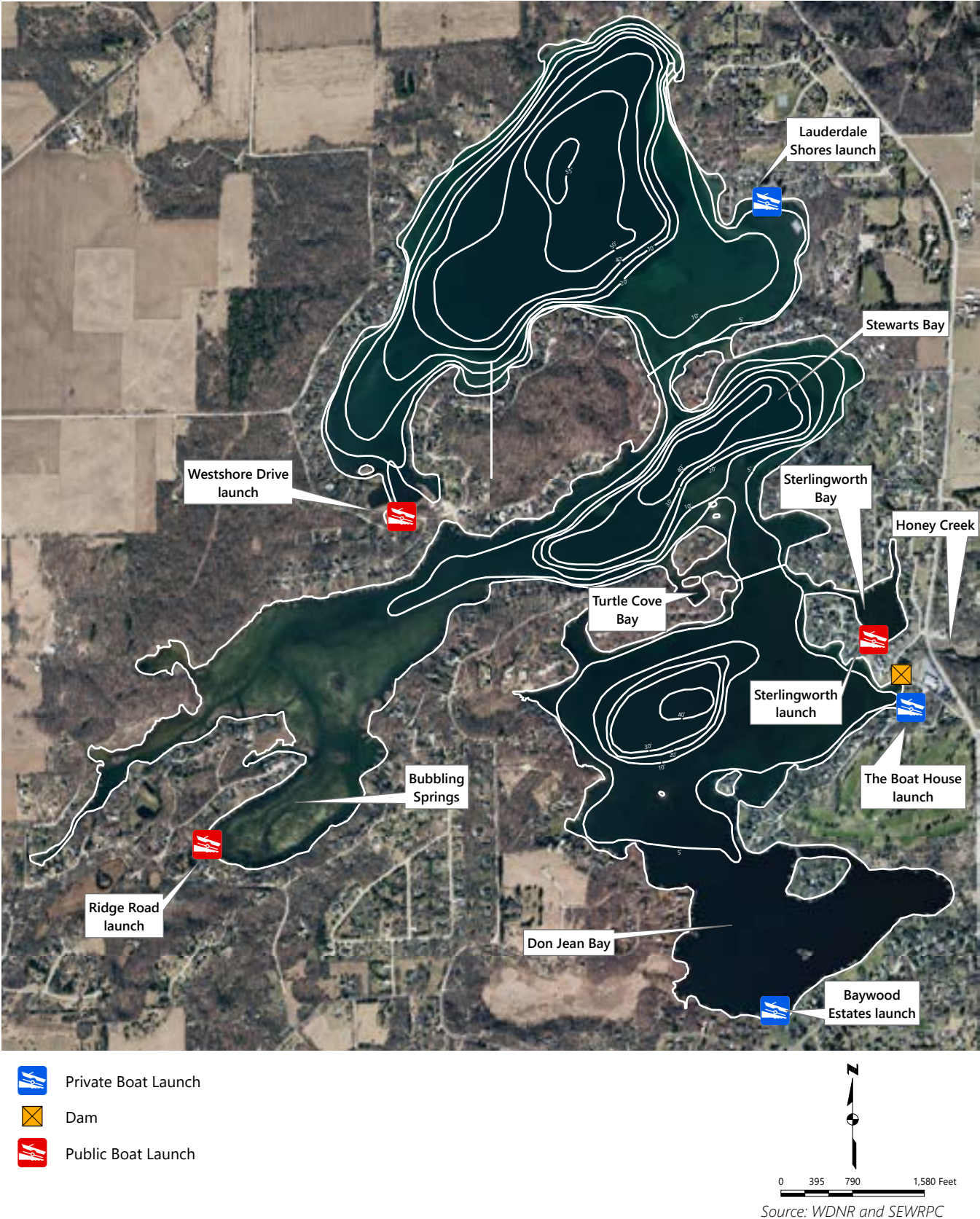
The Lauderdale Lakes are located in the Towns of LaGrange and Sugar Creek in Walworth County, Wisconsin (see Map 1.1). The Lakes have a combined surface area of 841 acres and are comprised of three natural basins of the Green, Middle, and Mill Lakes, linked as a result of the impounded outlet to Mill Lake. Additionally, this impoundment forms the headwaters of Honey Creek, a tributary stream to the Fox River. Although large areas of the Lakes are too deep to support growth of rooted aquatic plants, nearshore areas, bays, and shallow areas support aquatic vegetation. There are three public boat launches on the Lake: the Westshore Drive launch in the southwestern corner of Green Lake, the Ridge Road launch in the southwestern corner of Middle Lake, and the Sterlingworth launch on the eastern shore of Mill Lake. Additionally, there are three shared private boat launches on the Lake: Lauderdale Shores on the northeastern shore of Green Lake, The Boat House of Lauderdale Lakes on the northeastern shore of Mill Lake, and Baywood Estates on the southern shore of Mill Lake.

¹ SEWRPC Memorandum Report No. 143 (1st Edition), An Aquatic Plant Management Plan for the Lauderdale Lakes, Walworth County, Wisconsin, August 2001.

² SEWRPC Memorandum Report No. 143 (2nd Edition), An Aquatic Plant Management Plan for the Lauderdale Lakes, Walworth County, Wisconsin, 2nd Edition, July 2010.

³ SEWRPC Memorandum Report No. 143 (3rd Edition), An Aquatic Plant Management Plan for the Lauderdale Lakes, Walworth County, Wisconsin, 3rd Edition, October 2020.

Map 1.1
Bathymetry and Local Location Names of the Lauderdale Lakes



Green Lake is a 311-acre deep spring-fed headwater lake that outflows to Middle Lake, attaining a maximum depth of 57 feet.⁴ The previous aquatic plant survey of all three Lakes was performed by Commission staff in 2019 as a part of the 2020 Lauderdale Lakes APM plan update.⁵ A total of 19 species were observed in the 2019 survey, including several native beneficial species such as Sago pondweed (*Stuckenia pectinata*) and eelgrass (*Vallisneria spiralis*). Aquatic invasive species observed at this time included Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*).⁶

Middle Lake is a 259-acre deep lowland lake that is fed by both Green Lake and springs then outflows to Mill Lake. The maximum depth is approximately 50 feet.⁷ The 2019 survey observed a total of 27 species, including several native beneficial species such as wild rice (*Zizania* sp.) and common bladderwort (*Utricularia vulgaris*). Aquatic invasive species observed at the time of the 2019 survey included Eurasian watermilfoil and curly-leaf pondweed.⁸

Mill Lake is a 271-acre deep lowland lake that is fed by Middle Lake and outflows to Honey Creek, attaining a maximum depth of approximately 50 feet.⁹ The 2019 survey observed a total of 22 species, including several native beneficial species such as yellow water lily (*Nuphar variegata*) and water stargrass (*Heteranthera dubia*). Aquatic invasive species observed during the 2019 survey included Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*).¹⁰

The aquatic plant survey conducted for this update was conducted July 28th – August 4th, 2025 where Commission staff utilized the recommended baseline monitoring protocol employed by the WDNR.¹¹ There are seven WDNR-designated Sensitive Areas on the Lake, discussed more in Chapter 2 of this report; these areas are particularly important for sustaining elements of the lake's ecology, such as providing fish spawning and rearing habitat, and consequently intensive management is limited in these areas.¹²

The District manages aquatic plant growth on the Lakes to enhance navigation and recreational opportunities, primarily through mechanical harvesting. Aquatic plant management is regulated by the WDNR and requires a permit; every five years the District is required to reevaluate the aquatic plant community and update the aquatic plant management plan. To renew its permits to conduct this management, the District retained the Commission to reevaluate the Lake's aquatic plant community and update the aquatic plant management plan. This updated plan needs to consider the present status of the aquatic plant community, must identify plant community changes that may have occurred, must examine the potential success or lack of success for the current aquatic plant management strategies, must consider current trends and issues that pertain to aquatic plant management issues and techniques, and must describe the methods and procedures associated with the proposed continuation of aquatic plant management in the Lake.

⁴ Lake depth and acreage may vary by report source, data collection methods, time period, and conditions.

⁵ SEWRPC Memorandum Report No. 143 (3rd Edition), An Aquatic Plant Management Plan for the Lauderdale Lakes, Walworth County, Wisconsin, 3rd Edition, October 2020.

⁶ apps.dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=755800&page=invasive.

⁷ USGS, Hydrology and Water Quality of Lauderdale Lakes, Walworth County, Wisconsin, 1993-94. 1996.

⁸ apps.dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=755700&page=invasive.

⁹ USGS, op. cit., 1996.

¹⁰ apps.dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=755600&page=invasive.

¹¹ Hauxwell, J., S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky and S. Chase, Recommended baseline monitoring of aquatic plants in Wisconsin: sampling design, field and laboratory procedures, data entry and analysis, and applications, Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068, 2010.

¹² Wisconsin Department of Natural Resources, Lauderdale Lakes (Walworth County, Wisconsin) Integrated Sensitive Area Report, 2004.

This updated APM plan summarizes information and recommendations needed to best manage the aquatic plant communities of the Lakes. The plan covers four main topics:

- APM Goals and Objectives
- Aquatic Plant Community Changes and Quality
- Aquatic Plant Control Alternatives
- Recommended Aquatic Plant Management Plan

This memorandum focuses on approaches to monitor and control actively growing nuisance populations of aquatic plants and presents a range of alternatives that could potentially be used to achieve desired APM goals, providing specific recommendations related to each alternative. These data and suggestions can be valuable resources when developing requisite APM permit applications and implementing future aquatic plant management efforts.

Credit: Commission Staff

2.1 AQUATIC PLANT MANAGEMENT GOALS AND OBJECTIVES

Aquatic plant management (APM) programs are designed to further a variety of lake user and riparian landowner goals and desires. For example, most APM programs aim to improve lake navigability. However, APM programs must also be sensitive to other lake uses and must maintain or enhance a lake's ecological integrity. Consequently, APM program objectives are commonly developed in close consultation with many interested parties. The Lauderdale Lakes APM plan incorporated input from the Lauderdale Lakes Lake Management District (District) and the Wisconsin Department of Natural Resources (WDNR). Objectives of the Lauderdale Lakes APM program include the following:

- Effectively control the quantity and density of nuisance aquatic plant growth in well-targeted portions of the Lauderdale Lakes. This objective helps:
 - Enhance water-based recreational opportunities.
 - Allow opportunities for native and beneficial plant growth,
 - Improve community-perceived aesthetic values, and
 - Maintain or enhance the Lakes' natural resource value.
- Manage the Lakes in an environmentally sensitive manner in conformance with *Wisconsin Administrative Code* standards and requirements under Chapters NR 103 *Water Quality Standards for Wetlands*, NR 107 *Aquatic Plant Management*, and NR 109 *Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations*. Following these rules helps the District preserve and enhance the Lakes' water quality, their biotic communities, their habitat value, and their essential structure and relative function in relation to adjacent areas.
- Protect and maintain public health and promote public comfort, convenience, and welfare while safeguarding the Lakes' ecological health through environmentally sound management of vegetation, wildlife, fish, and other aquatic/semi-aquatic organisms in and around the Lauderdale Lakes.

- Promote a high-quality water-based experience for residents and visitors to the Lauderdale Lakes consistent with the policies and practices of the WDNR, as described in the regional water quality management plan, as amended.¹³

To meet these objectives, the District executed an agreement with the Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC) to investigate the characteristics of the Lauderdale Lakes and to develop an aquatic plant management update. As part of this planning process, surveys of the aquatic plant community and comparisons to results of previous surveys were conducted. This chapter presents the results of each of these inventories.

2.2 AQUATIC PLANT COMMUNITY COMPOSITION, CHANGE, AND QUALITY

All healthy lakes have aquatic plants and native aquatic plants form a foundation part of the lake ecosystem. Aquatic plants form an integral part of the aquatic food web, converting sediments and inorganic nutrients present in the water into organic compounds that are directly available as food to other aquatic organisms. Through photosynthesis, plants utilize energy from sunlight and release the oxygen required by many other aquatic life forms into the water. Aquatic plants also serve several other valuable functions in a lake ecosystem, including:

- Improving water quality by filtering excess nutrients from the water
- Providing habitat for invertebrates, amphibians, reptiles, and fishes
- Stabilizing lake bottom substrates
- Supplying food for waterfowl and various lake-dwelling animals

Even though aquatic plants may hinder human use and/or access to a lake, aquatic plants should not necessarily be eliminated or even significantly reduced in abundance because they often support many other beneficial functions (see Table 2.1). For example, water lilies play a significant role in providing shade, habitat, and food for fish and other important aquatic organisms. They also help prevent damage to the lakeshore by dampening the power of waves that could otherwise erode the shoreline. Additionally, the shade that these plants provide helps reduce the growth of undesirable plants because it limits the amount of sunlight reaching the lake bottom. A healthy aquatic plant community can also help to protect water quality and reduce occurrences of harmful algal blooms.¹⁴ Given these benefits, large-scale removal of native plants that may be perceived as a nuisance and should be avoided when developing plans for aquatic plant management.

Sensitive Areas

Within or immediately adjacent to bodies of water, the WDNR, pursuant to authority granted under Chapter 30 of the *Wisconsin State Statutes* and Chapter NR 170 of the *Wisconsin Administrative Code*, can designate environmentally sensitive areas on lakes that have special biological, geological, ecological, or archaeological significance, “offering critical or unique fish and wildlife habitat, including seasonal or life-stage requirements, or offering water quality or erosion control benefits of the body of water”. Wisconsin law mandates special protections for these “Sensitive Areas,” or “Critical Habitat Designation” areas, which are home to approximately eighty percent of the plants and animals on the state’s endangered and threatened species list. A significant part of the critical habitat designation lies in the fact that it assists waterfront owners by identifying these areas so that they can design their waterfront projects to protect habitat and ensure the long-term health of the lake where they live. If a project is proposed in a designated Sensitive Area, the permit process allows WDNR to ensure that proposed projects will not harm these sensitive resources.

¹³ *SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin—2000, Volume One, Inventory Findings, September 1978, Volume Two, Alternative Plans, February 1979, Volume Three, Recommended Plan, June 1979, and SEWRPC Memorandum Report No. 93, A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, March 1995.*

¹⁴ dnr.wisconsin.gov/topic/lakes/bluegreenalgae.

Table 2.1
Ecological Qualities Associated with a Subset of Aquatic Plant Species in the Lauderdale Lakes

Aquatic Plant Species Present	Ecological Significance
<i>Ceratophyllum demersum</i> (coontail)	Provides good shelter for young fish; supports insects valuable as food for fish and ducklings
<i>Chara</i> spp. (muskgrasses)	A favorite waterfowl food and fish habitat, especially for young fish
<i>Elodea canadensis</i> (common waterweed)	Provides shelter and support for insects which are valuable as fish food
<i>Heteranthera dubia</i> (water stargrass)	Locally important food source for waterfowl and forage for fish; native
<i>Myriophyllum sibiricum</i> (northern watermilfoil)	Leaves and fruit provide food for waterfowl and shelter and foraging for fish
<i>Najas flexilis</i> (slender naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
<i>Najas guadalupensis</i> (southern naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
<i>Nymphaea odorata</i> (white water lily)	Seeds consumed by waterfowl while rhizoids consumed by mammals
<i>Potamogeton friesii</i> (Fries' pondweed)	Seeds provide food for waterfowl and habitat for fish and aquatic invertebrates
<i>Potamogeton gramineus</i> (variable pondweed)	The fruit is an important food source for many waterfowl; provides food for muskrat, deer, and beaver; native
<i>Potamogeton illinoensis</i> (Illinois pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by waterfowl
<i>Potamogeton zosteriformis</i> (flat-stem pondweed)	Provides some food for ducks; native
<i>Ranunculus aquatilis</i> (white water crowfoot)	Provides habitat for fish and macroinvertebrates
<i>Stuckenia pectinata</i> (Sago pondweed)	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish; native
<i>Utricularia</i> spp. (bladderworts)	Stems provide food and cover for fish; native
<i>Vallisneria americana</i> (eelgrass/water celery)	Provides good shade and shelter, supports insects, and is valuable fish food; native
<i>Zizania</i> sp. (wild rice)	Food source for waterfowl; provides muskrat lodge construction material; economic and cultural value for humans; native

Note: Information obtained from A Manual of Aquatic Plants by Norman C. Fassett, University of Wisconsin Press; Guide to Wisconsin Aquatic Plants, Wisconsin Department of Natural Resources; and, Through the Looking Glass: A Field Guide to Aquatic Plants, Wisconsin Lakes Partnership, University of Wisconsin-Extension.

Source: SEWRPC

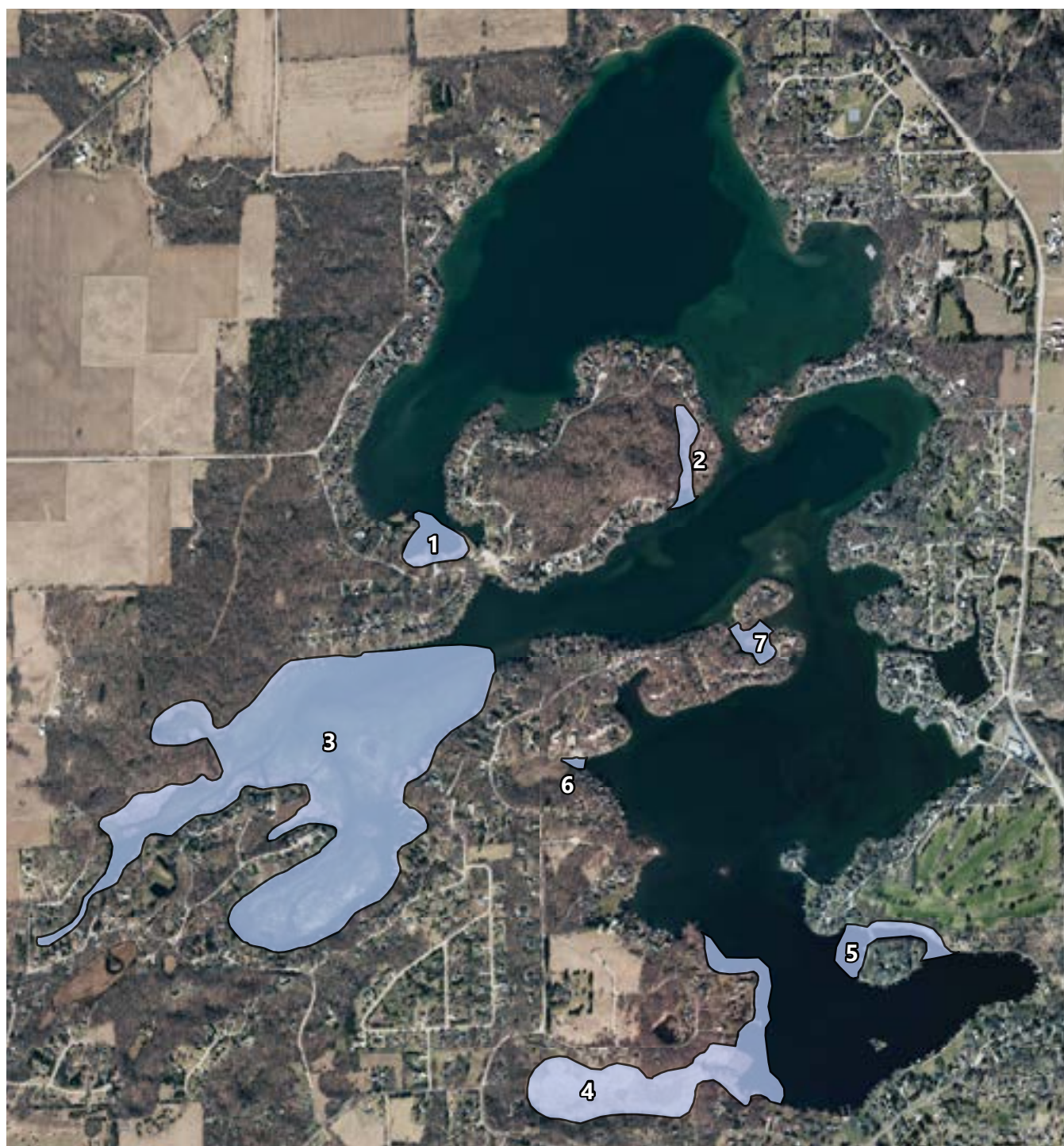
The WDNR has identified seven Sensitive Areas in the Lauderdale Lakes (see Map 2.1).¹⁵ The following provides a summary of the Sensitive Area descriptions and their ecological values from the WDNR Sensitive Area designation report from the early 2000s.¹⁶ Though these areas are subject to change over time, and may shift in community composition, these designated Sensitive Areas provide unique and essential ecosystem services within the Lauderdale Lakes system. These sensitive areas are mentioned throughout the report. A brief overview of these Areas and their benefits on the Lakes is summarized below.

- Sensitive Area (SA) 1 is on the southwest end of Green Lake. The emergent (cattail, bulrushes, and sedges), submergent (coontail, pondweeds, and bladderworts), and floating-leaf (white water lily) vegetation provides habitat for multiple species of fish, waterfowl, muskrat, and opossum. The WDNR also noted that the bay acts as a nutrient and sediment trap that enhances water quality.
- Sensitive Area 2 is in Middle Lake and consists of a small bay dominated by water willows which aid in filtering runoff that enters the bay. The open water areas have silt and muck sediments, with diverse aquatic vegetation. While the area is not critical to fisheries, it is unique and important for wildlife habitat not found around the Lakes due to surrounding development.

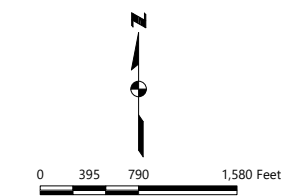
¹⁵ The WDNR is granted authority to define sensitive areas under Section NR 107.05(3)(i) of the Wisconsin Administrative Code.

¹⁶ Wisconsin Department of Natural Resources, Lauderdale Lakes (Walworth County, Wisconsin) Integrated Sensitive Area Report.

Map 2.1
Sensitive Areas in the Lauderdale Lakes



 Sensitive Areas



Source: WDNR and SEWRPC

- Sensitive Area 3 consists of the western third of Middle Lake and is the largest sensitive area in the Lauderdale Lakes system. The area hosts the greatest diversity of emergent, submergent, and floating plants, which provide essential spawning, feeding, and cover habitat for fish. The area additionally supports wild rice, an important cultural food source as well as an indicator of healthy wetlands and waterways.
- Sensitive Area 4 is in Mill Lake on the southwestern shore. This area is shallow, and its proximity to the wetland provides synergistic effects for water filtration and sediment trapping that aid in the Lakes' water quality. The area provides locally important wildlife and fish habitat.
- Sensitive Area 5 is in Don Jean Bay, with notable growth of large-leaf pondweed. Little water flows through the area, and the area acts as a nutrient and sediment trap which enhances water quality. The variety of aquatic plants controls shoreline erosion and provides fish spawning, nursery, feeding, and cover habitat.
- Sensitive Area 6 is located on the northwest corner of Mill Lake. The area is shallow, composed of silt and muck sediment that aids in trapping nutrients and incoming sediment. Aquatic vegetation like arrowhead aids in controlling shoreline erosion. The area is noted for providing food, coverage, and habitat for fish and wildlife, with a diverse wetland.
- Sensitive Area 7 is a shallow waterway located between Middle and Mill Lakes, with silt covering a firm substrate underneath. The aquatic vegetation aids in erosion, fish habitat and spawning, wildlife areas, and local diversity of the adjacent wetland (water willow, marsh fern, Canada bluejoint, sweet flag amongst others).

Aquatic Plant Surveys

The Lakes' aquatic plant communities were evaluated several times in the past to support aquatic plant management permit applications (see Tables 2.2, 2.3, and 2.4). Commission staff surveyed the Lakes' aquatic plants in 1999,¹⁷ 2008,¹⁸ 2019¹⁹, and 2025²⁰ while Stantec surveyed the Lakes in 2014. To establish long-term management goals and permitted management of the Lakes, the District has decided to re-evaluate the Lakes' aquatic plant community and prepare an updated aquatic plant management plan for the Lakes. The 2019 and 2025 surveys both used the same point-intercept (PI) grid and methodology.^{21,22,23} In this method, sampling sites are based on predetermined global positioning system (GPS) location points that are arranged in a grid pattern across the entire surface of a lake.

The grid patterns of Green, Middle, and Mill Lake consist of 708 points, 600 points, and 471 points, respectively (see Figures 2.1, 2.2, and 2.3) giving a total of 1,779 sample points for the Lauderdale Lakes.²⁴ These points, provided by WDNR, allow the types and abundance of aquatic plants to be directly contrasted

¹⁷ SEWRPC Memorandum Report No. 143, op. cit.

¹⁸ SEWRPC Memorandum Report No. 143, 2nd Edition, op. cit.

¹⁹ SEWRPC Memorandum Report No. 143, 3rd Edition, op. cit.

²⁰ Previous aquatic plant surveys on the Lakes, not surveyed by the Commission, are detailed in SEWRPC Memorandum Report No. 143, 3rd Edition.

²¹ Aquatic plant sampling methodology changed from transect-based methods in the earlier surveys to a point-intercept method beginning in 2014.

²² R. Jesson, and R. Lound, Minnesota Department of Conservation Game Investigational Report No. 6, An Evaluation of a Survey Technique for Submerged Aquatic Plants, 1962; as refined in the Memo from Stan Nichols to J. Bode, J. Leverence, S. Borman, S. Engel, and D. Helsel, "Analysis of Macrophyte Data for Ambient Lakes-Dutch Hollow and Redstone Lakes Example," University of Wisconsin-Extension, February 4, 1994

²³ J. Hauxwell, S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky, and S. Chase, Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry and Analysis, and Applications, Wisconsin Department of Natural Resources, Bureau of Science Services, Publication No. PUB-SS-1068 201, March 2010.

²⁴ Although the PI grids generally split the lakes at the access channels, the PI grid for Middle Lake extends further north into the southern portion of what would hydrologically appear to be Green Lake.

Table 2.2
Submerged Aquatic Plant Species Observed in Green Lake: 1967-2025

Aquatic Plant Species	Native or Invasive	1967	1999	2008	2014	2019	2025
<i>Ceratophyllum demersum</i> (coontail)	Native	X	X	X	--	X	X
<i>Chara</i> spp. (muskgrass)	Native	X	X	X	X	X	X
<i>Elodea canadensis</i> (common waterweed)	Native	X	X	X	X	X	X
<i>Heteranthera dubia</i> (water stargrass)	Native	--	X	X	X	X	X
<i>Myriophyllum sibiricum</i> (northern water milfoil)	Native	X	X	X	--	--	--
<i>Myriophyllum spicatum</i> (Eurasian water milfoil)	Invasive	--	X	X	X	X	X
<i>Najas flexilis</i> (slender naiad)	Native	X	X	X	X	X	X
<i>Najas marina</i> (spiny naiad)	Naturalized	X	X	X	X	X	X
<i>Nitella</i> spp. (stonewort)	Native	X	--	--	--	--	--
<i>Nitellopsis obtusa</i> (starry stonewort)	Invasive	--	--	--	--	--	X
<i>Nuphar variegata</i> (spatterdock)	Native	X	X	X	X	X	X
<i>Nymphaea odorata</i> (white-water lily)	Native	X	X	X	--	X	X
<i>Potamogeton alpinus</i> (alpine pondweed)	Native	--	X	--	X	--	--
<i>Potamogeton crispus</i> (curly-leaf pondweed)	Invasive	X	X	X	--	--	X
<i>Potamogeton foliosus</i> (leafy pondweed)	Native	--	X	X	--	--	--
<i>Potamogeton friesii</i> (Fries' pondweed)	Native	--	--	--	--	X	X
<i>Potamogeton gramineus</i> (variable pondweed)	Native	X	--	X	X	X	X
<i>Potamogeton illinoensis</i> (Illinois pondweed)	Native	--	X	X	--	--	X
<i>Potamogeton illinoensis</i> X <i>natans</i> (hybrid Illinois x floating-leaf pondweed)	Native	--	--	--	--	--	X
<i>Potamogeton natans</i> (floating-leaf pondweed)	Native	X	--	X	--	X	X
<i>Potamogeton nodosus</i> (long-leaf pondweed)	Native	X	--	--	--	--	--
<i>Potamogeton praelongus</i> (white-stem pondweed)	Native	X	--	--	--	X	--
<i>Potamogeton pusillus</i> (small pondweed)	Native	--	--	X	--	--	--
<i>Potamogeton richardsonii</i> (clasping-leaf pondweed)	Native	--	--	X	--	--	--
<i>Potamogeton</i> spp. (pondweed)	Native	X	X	--	--	--	--
<i>Potamogeton zosteriformis</i> (flat-stem pondweed)	Native	X	X	X	--	X	X
<i>Ranunculus aquatilis</i> (white water crowfoot)	Native	X	--	--	--	--	X
<i>Sagittaria cuneata</i> (arrowhead)	Native	--	--	--	X	X	X
<i>Stuckenia pectinata</i> (sago pondweed)	Native	X	X	X	X	X	X
<i>Utricularia minor</i> (small bladderwort)	Native	--	--	--	--	X	--
<i>Utricularia</i> spp. (bladderwort)	Native	X	--	X	--	--	--
<i>Utricularia vulgaris</i> (common bladderwort)	Native	--	--	--	X	X	X
<i>Vallisneria spiralis</i> (eelgrass/water celery)	Native	X	X	X	X	X	X
Total Species		20	18	21	13	19	22

Note: Species presence was reported collectively for the Lauderdale Chain of Lakes in the 1967 survey. Observations did not specify Green, Middle, or Mill Lake.

Source: Stantec, WDNR, and SEWRPC

to prior point-intercept surveys. At each grid point sampling site, a single rake haul is taken and a qualitative assessment of the rake fullness, on a scale of zero to three, is made for each species identified. As both the 2019 and 2025 surveys utilized this methodology, the consistency of sampling locations enables more detailed evaluation of aquatic plant abundance and distribution change than has been possible in the past.

Commission staff conducted the 2025 survey on the Lauderdale Lakes on July 28th through August 4th. Conditions during the surveys were adequate, with sunny skies, low wind speeds, and low boat traffic for most of the survey, although traffic did increase substantially toward the end of each survey day. The Commission was assisted by the provision of a volunteered pontoon boat as well as several volunteer boat drivers who navigated the entire Green and Mill Lake surveys as well as the deep-water portion of Middle Lake. Commission staff surveyed the shallow western portion of Middle Lake using the Commission's canoe to reduce disturbance to the sensitive habitat in this area. The Lakes' water clarity was adequate for most of the survey, which enhanced visual observations of aquatic plant species within six feet of the sampling location. However, Mill Lake had lower water clarity than either Green or Middle Lakes which

Table 2.3
Submerged Aquatic Plant Species Observed in Middle Lake: 1967-2025

Aquatic Plant Species	Native or Invasive	1967	1999	2008	2014	2019	2025
<i>Ceratophyllum demersum</i> (coontail)	Native	X	X	X	X	X	X
<i>Chara</i> spp. (muskgrass)	Native	X	X	X	X	X	X
<i>Elodea canadensis</i> (common waterweed)	Native	X	X	X	X	X	X
<i>Heteranthera dubia</i> (water stargrass)	Native	--	X	--	X	--	X
<i>Lemna minor</i> (small duckweed)	Native	X	X	--	--	X	X
<i>Myriophyllum sibiricum</i> (northern water milfoil)	Native	X	X	X	--	--	X
<i>Myriophyllum spicatum</i> (Eurasian water milfoil)	Invasive	--	X	X	X	X	X
<i>Myriophyllum verticillatum</i> (whorled water milfoil)	Native	--	--	--	X	X	--
<i>Najas flexilis</i> (slender naiad)	Native	X	X	X	X	X	X
<i>Najas guadalupensis</i> (southern naiad)	Native	--	--	--	--	X	X
<i>Najas marina</i> (spiny naiad)	Naturalized	X	X	X	X	X	X
<i>Nitella</i> spp. (stonewort)	Native	X	--	--	--	X	X
<i>Nitella tenuissima</i> (small nitella)	Native	--	--	--	--	X	--
<i>Nitellopsis obtusa</i> (starry stonewort)	Invasive	--	--	--	--	--	X
<i>Nuphar variegata</i> (spatterdock)	Native	X	X	X	X	X	X
<i>Nymphaea odorata</i> (white water lily)	Native	X	X	X	X	X	X
<i>Potamogeton crispus</i> (curly-leaf pondweed)	Invasive	X	X	X	X	X	X
<i>Potamogeton foliosus</i> (leafy pondweed)	Native	--	--	X	X	--	--
<i>Potamogeton friesii</i> (Fries' pondweed)	Native	--	--	--	--	X	X
<i>Potamogeton gramineus</i> (variable pondweed)	Native	X	--	X	X	X	X
<i>Potamogeton illinoensis</i> (Illinois pondweed)	Native	--	X	X	X	--	X
<i>Potamogeton natans</i> (floating-leaf pondweed)	Native	X	X	--	X	X	X
<i>Potamogeton nodosus</i> (long-leaf pondweed)	Native	X	--	X	--	--	--
<i>Potamogeton praelongus</i> (white-stem pondweed)	Native	X	--	--	--	--	--
<i>Potamogeton richardsonii</i> (clasping-leaf pondweed)	Native	--	--	--	X	--	--
<i>Potamogeton</i> spp. (pondweed)	Native	X	X	-	--	--	--
<i>Potamogeton zosteriformis</i> (flat-stem pondweed)	Native	X	X	X	X	X	--
<i>Ranunculus aquatilis</i> (white water crowfoot)	Native	X	--	--	--	X	X
<i>Sagittaria cuneata</i> (arrowhead)	Native	--	--	--	--	X	X
<i>Sagittaria</i> sp. (arrowhead)	Native	--	X	--	X	--	--
<i>Schoenoplectus acutus</i> (Hardstem bulrush)	Native	--	X	X	X	X	X
<i>Schoenoplectus subterminalis</i> (water bulrush)	Native	--	X	--	--	--	--
<i>Sparganium emersum</i> (short-stemmed bur-reed)	Native	--	--	--	--	X	--
<i>Sparganium natans</i> (small bur-reed)	Native	--	--	X	--	X	X
<i>Sparganium</i> sp. (Bur-reed)	Native	--	--	--	X	--	X
<i>Spirodela polyrhiza</i> (large duckweed)	Native	--	--	--	--	--	X
<i>Stuckenia pectinata</i> (Sago pondweed)	Native	X	X	X	X	X	X
<i>Typha</i> sp. (cattail)	Native	X		X	X	--	X
<i>Utricularia geminiscapa</i> (twin-stemmed bladderwort)	Native	--	--	--	X	--	--
<i>Utricularia gibba</i> (creeping bladderwort)	Native	--	--	--	X	--	X
<i>Utricularia minor</i> (small bladderwort)	Native	--	--	--	--	--	X
<i>Utricularia</i> spp. (bladderwort)	Native	X	X	X	--	--	--
<i>Utricularia vulgaris</i> (common bladderwort)	Native	--	--	--	X	X	X
<i>Vallisneria americana</i> (eelgrass/water celery)	Native	X	X	X	X	X	X
<i>Zizania</i> sp. (wild rice)	Native	--	X	X	X	X	X
Total Species		22	23	22	27	27	32

Note: Species presence was reported collectively for the Lauderdale Chain of Lakes in the 1967 survey. Observations did not specify Green, Middle, or Mill Lake.

Source: Stantec, WDNR, and SEWRPC

Table 2.4
Aquatic Plant Species Observed in Mill Lake: 1967-2025

Aquatic Plant Species	Native or Invasive	1967	1999	2008	2014	2019	2025
<i>Ceratophyllum demersum</i> (coontail)	Native	X	X	X	X	X	X
<i>Chara</i> spp. (muskgrass)	Native	X	X	X	X	X	X
<i>Elodea canadensis</i> (common waterweed)	Native	X	X	X	X	X	X
<i>Heteranthera dubia</i> (water stargrass)	Native	--	X	X	X	X	X
<i>Lemna minor</i> (small duckweed)	Native	--	--	X	--	X	X
<i>Myriophyllum sibiricum</i> (northern water milfoil)	Native	X	X	X	--	--	--
<i>Myriophyllum spicatum</i> (Eurasian water milfoil)	Invasive	--	X	X	--	X	X
<i>Myriophyllum verticillatum</i> (whorled water milfoil)	Native	--	--	--	--	X	X
<i>Najas flexilis</i> (slender naiad)	Native	X	X	X	X	X	X
<i>Najas guadalupensis</i> (southern naiad)	Native	--	--	--	--	X	X
<i>Najas marina</i> (spiny naiad)	Naturalized	X	X	X	X	X	X
<i>Nitella</i> spp. (stonewort)	Native	X	--	X	--	X	-
<i>Nitellopsis obtusa</i> (starry stonewort)	Invasive	--	--	--	--	--	X
<i>Nuphar variegata</i> (spatterdock)	Native	X	X	X	X	X	X
<i>Nymphaea odorata</i> (white-water lily)	Native	X	X	X	X	X	X
<i>Potamogeton alpinus</i> (Alpine pondweed)	Native	--	--	--	X	--	--
<i>Potamogeton amplifolius</i> (large-leaf pondweed)	Native	--	X	X	--	X	X
<i>Potamogeton crispus</i> (curly-leaf pondweed)	Invasive	X	X	X	--	X	X
<i>Potamogeton friesii</i> (Fries' pondweed)	Native	--	--	--	--	--	X
<i>Potamogeton foliosus</i> (leafy pondweed)	Native	--	X	X	--	--	--
<i>Potamogeton gramineus</i> (variable pondweed)	Native	X	--	X	--	X	X
<i>Potamogeton illinoensis</i> (Illinois pondweed)	Native	--	X	--	--	--	--
<i>Potamogeton natans</i> (floating-leaf pondweed)	Native	X	X	--	X	X	X
<i>Potamogeton nodosus</i> (long-leaf pondweed)	Native	X	--	X	--	--	--
<i>Potamogeton praelongus</i> (white-stem pondweed)	Native	X	--	--	--	--	--
<i>Potamogeton pusillus</i> (small pondweed)	Native	--	--	X	--	--	--
<i>Potamogeton</i> spp. (pondweed)	Native	X	--	--	--	--	--
<i>Potamogeton zosteriformis</i> (flat-stem pondweed)	Native	X	X	X	X	X	X
<i>Ranunculus aquatilis</i> (white water crowfoot)	Native	X	--	--	--	--	--
<i>Sagittaria cuneata</i> (arrowhead)	Native	--	--	--	--	X	X
<i>Schoenoplectus pungens</i> (Three-square bulrush)	Native	--	--	--	--	--	X
<i>Spirodela polyrrhiza</i> (large duckweed)	Native	--	--	--	--	--	X
<i>Stuckenia pectinata</i> (sago pondweed)	Native	X	X	X	X	X	X
<i>Utricularia</i> spp. (bladderwort)	Native	X	X	--	--	--	-
<i>Utricularia vulgaris</i> (common bladderwort)	Native	--	--	X	X	X	X
<i>Vallisneria americana</i> (eelgrass/water celery)	Native	X	X	X	X	X	X
Total Species		20	19	22	14	22	25

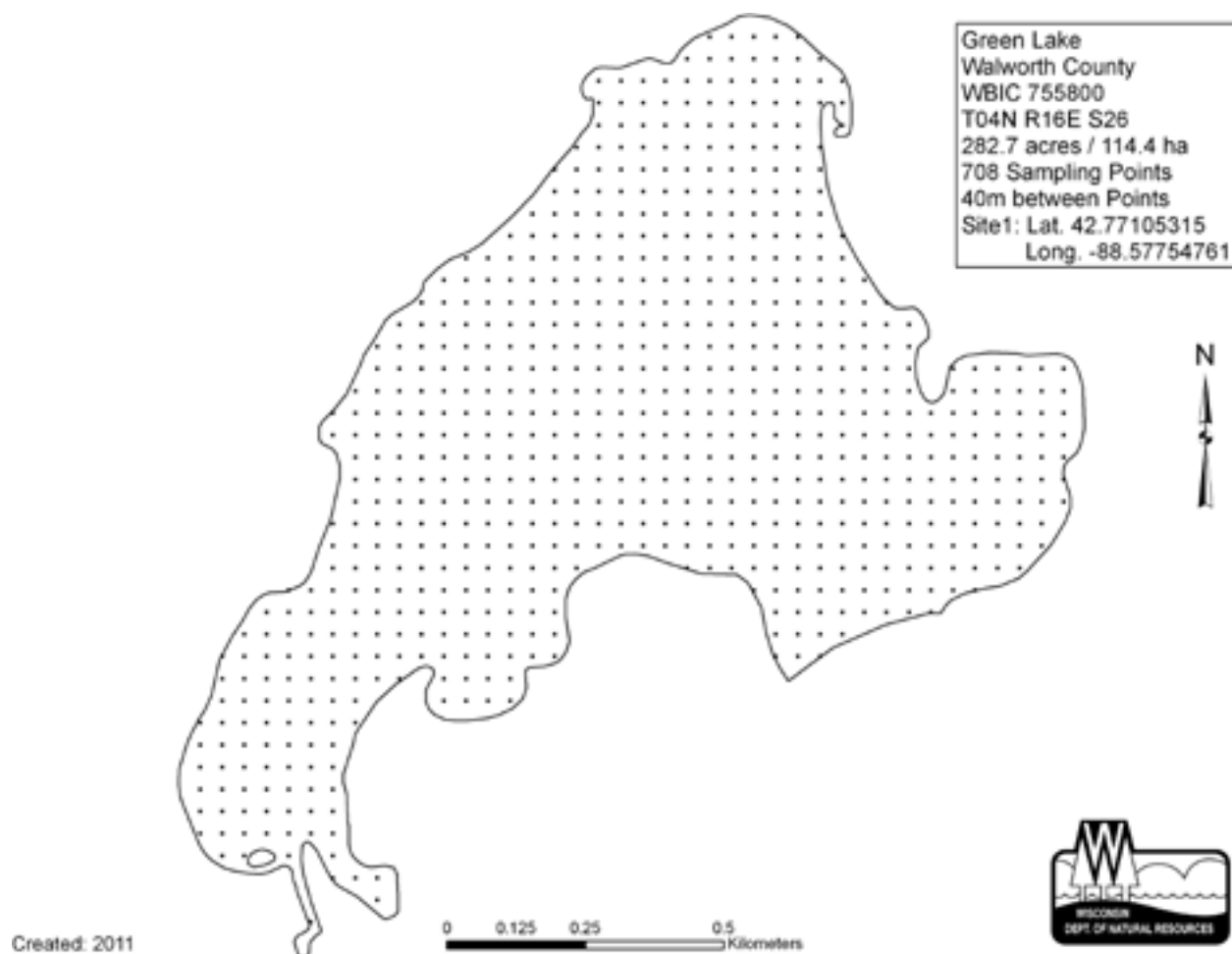
Note: Species presence was reported collectively for the Lauderdale Chain of Lakes in the 1967 survey. Observations did not specify Green, Middle, or Mill Lake.

Source: Stantec, WDNR, and SEWRPC

may have reduced the number of visual observations for that lake. In general, the aquatic plant specimens were mature, and several species were in flower (e.g., white water lily (*Nymphaea odorata*)). In addition to the aquatic plants, Commission staff observed a nesting bald eagle, fish, waterfowl, and turtles during the survey.

While Commission staff strived to survey as much of the Lakes as feasible, certain areas were not surveyed in 2025 survey. These areas included central portions of each of the three Lake bodies which were determined to be too deep for vascular aquatic plants to grow. Other points that were not surveyed were due to proximity to docks, temporary obstacles, and points that were deemed to be on shore or too shallow to access, such as densely vegetated nearshore areas in the western portion of Mill Lake.

Figure 2.1
Aquatic Plant Point Intercept Grid for Green Lake

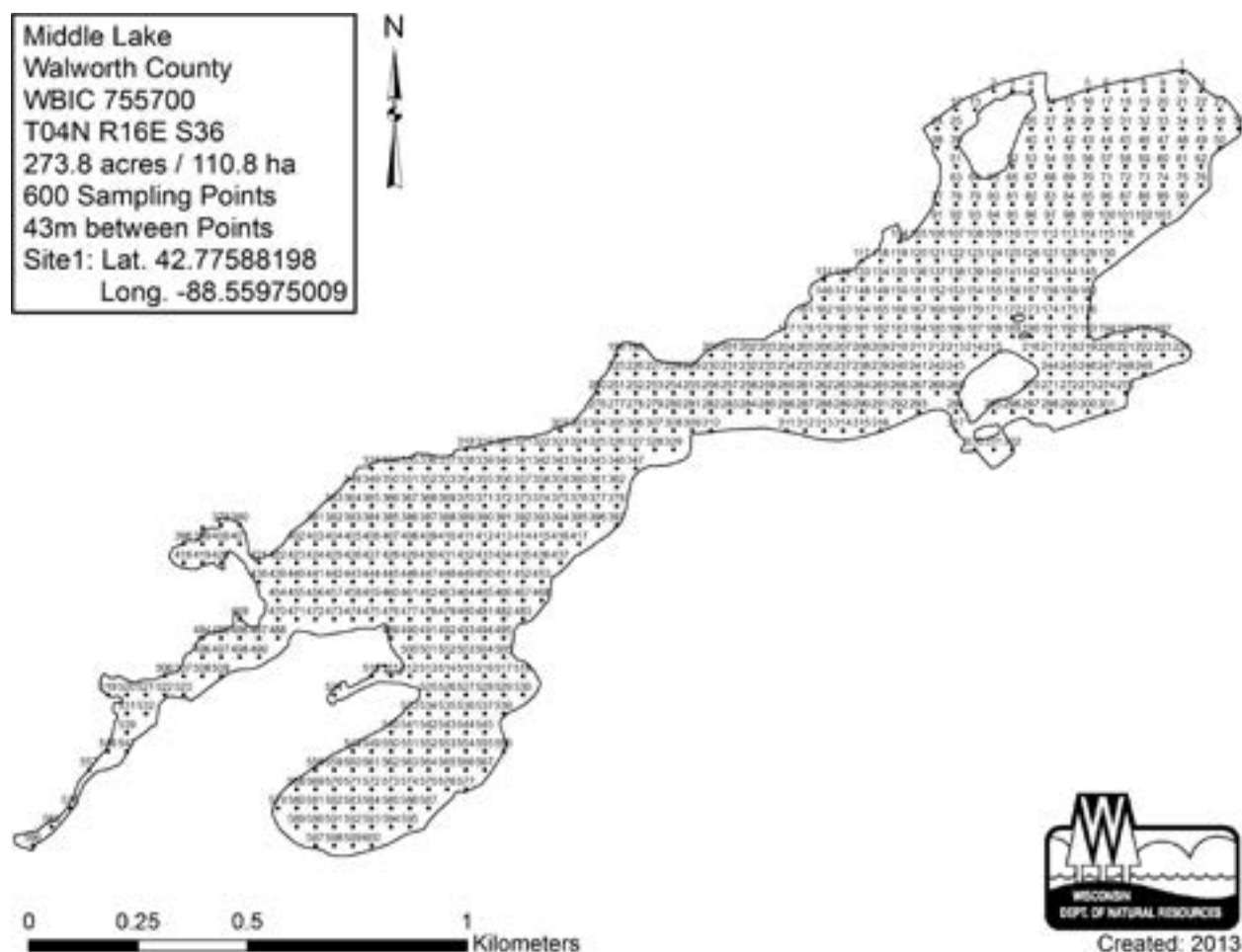


Aquatic Plant Survey Metrics

Each aquatic plant species has preferred habitat conditions in which that species thrives as well as conditions that limit or completely inhibit its growth. For example, water conditions (e.g., depth, clarity, source, alkalinity, and nutrient concentrations), substrate composition, the presence of or absence of water movement, and pressure from herbivory and/or competition all can influence the type of aquatic plants found in a water body. All other factors being equal, water bodies with a diverse array of habitat variables are more likely to host a diverse aquatic plant community. For similar reasons, some areas of a particular lake may contain plant communities with low diversity, while other areas of the same lake may exhibit higher diversity. Historically, human manipulation has often favored certain plants and reduced biological diversity (biodiversity). Thoughtful aquatic plant management can help maintain or even enhance aquatic plant biodiversity.

Several metrics are useful to describe aquatic plant community condition and to design management strategies. These metrics include total rake fullness, maximum depth of colonization, species richness, biodiversity, evaluation of sensitive species, and relative species abundance. Metrics derived from the 2019 and 2025 point-intercept surveys are described below.

Figure 2.2
Aquatic Plant Point Intercept Grid for Middle Lake



Source: WDNR

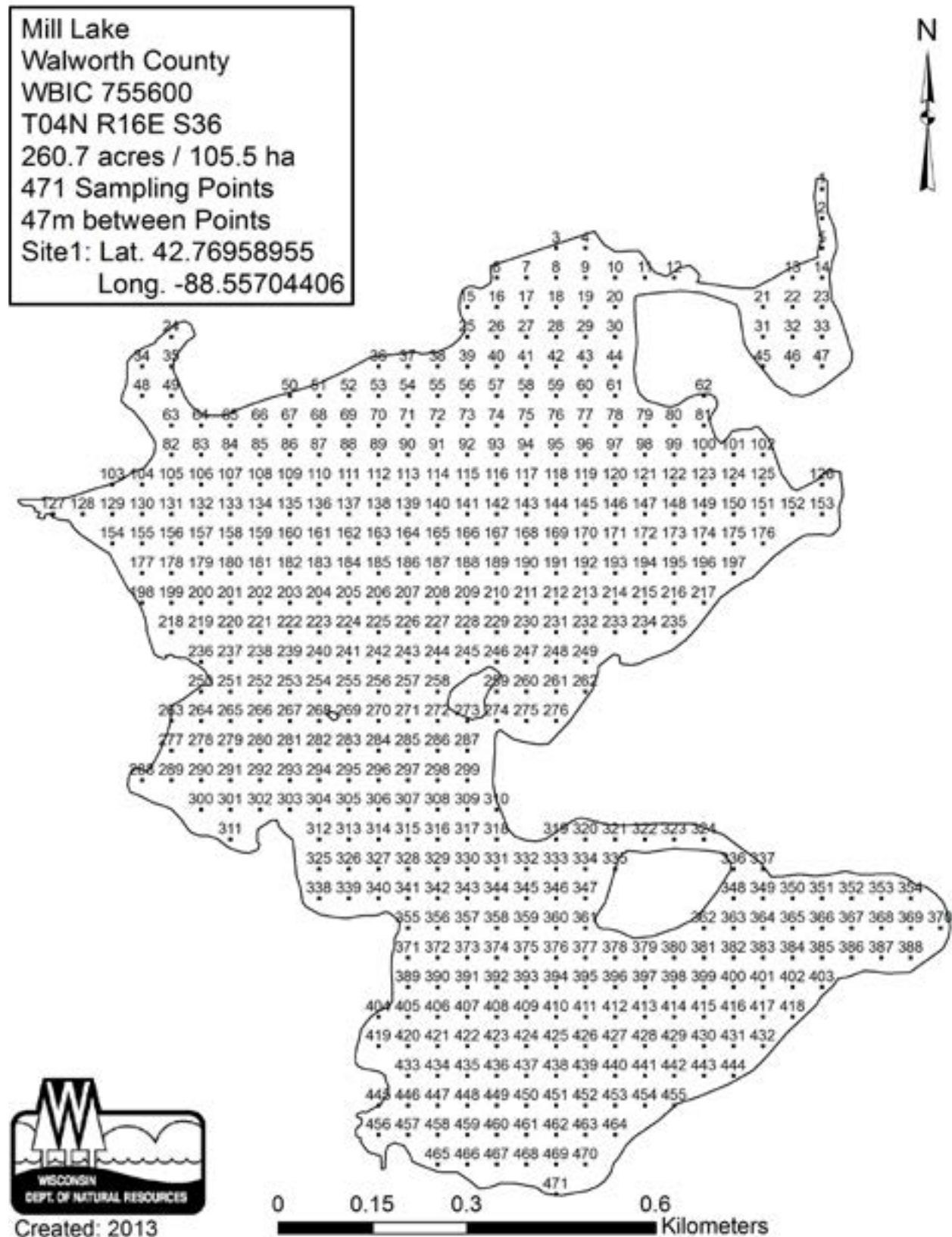
Total Rake Fullness

As described earlier in this section, Commission staff qualitatively rated the plant abundance at each survey point by how much of the sampling rake was covered by all aquatic plant species.²⁵ This rating, called total rake fullness, can be a useful metric evaluating general abundance of aquatic plants as part of the point-intercept survey. In the 2025 survey, the average rake fullness was 1.41, 1.29, and 1.51 on Green, Middle, and Mill Lakes, respectively (see Figure 2.4 and Table 2.5). Compared to the 2019 survey, total rake fullness decreased in Middle and Mill Lakes (decrease of rake fullness from 1.69 in 2019 to 1.29 in 2025 in Middle Lake and a decrease of 1.73 in 2019 to 1.51 in 2025 in Mill Lake) and slightly increased in Green Lake (an increase of rake fullness from 1.32 in 2019 to 1.41 in 2025). These metrics indicate that aquatic plant density decreased both in Middle and Mill Lakes but increased in Green Lake.

Volunteer and Commission staff noted a consistent lack of aquatic vegetation in the channels connecting the Lauderdale Lakes, most likely due to boat traffic limiting plant establishment (i.e., cutting by propellers, mechanical stress from water movement created by boats, and likely scouring of the sediment—limiting nutrient availability). The lack of aquatic vegetation was often on a linear strip and may not have fallen on a particular PI point. Additionally, aquatic vegetation was not seen near some piers where chemical treatments may have been applied for navigation purposes.

²⁵ This method follows the standard WDNR protocol.

Figure 2.3
Aquatic Plant Point Intercept Grid for Mill Lake



Source: WDNR

Figure 2.4
Total Rake Fullness in the Lauderdale Lakes: Summer 2025

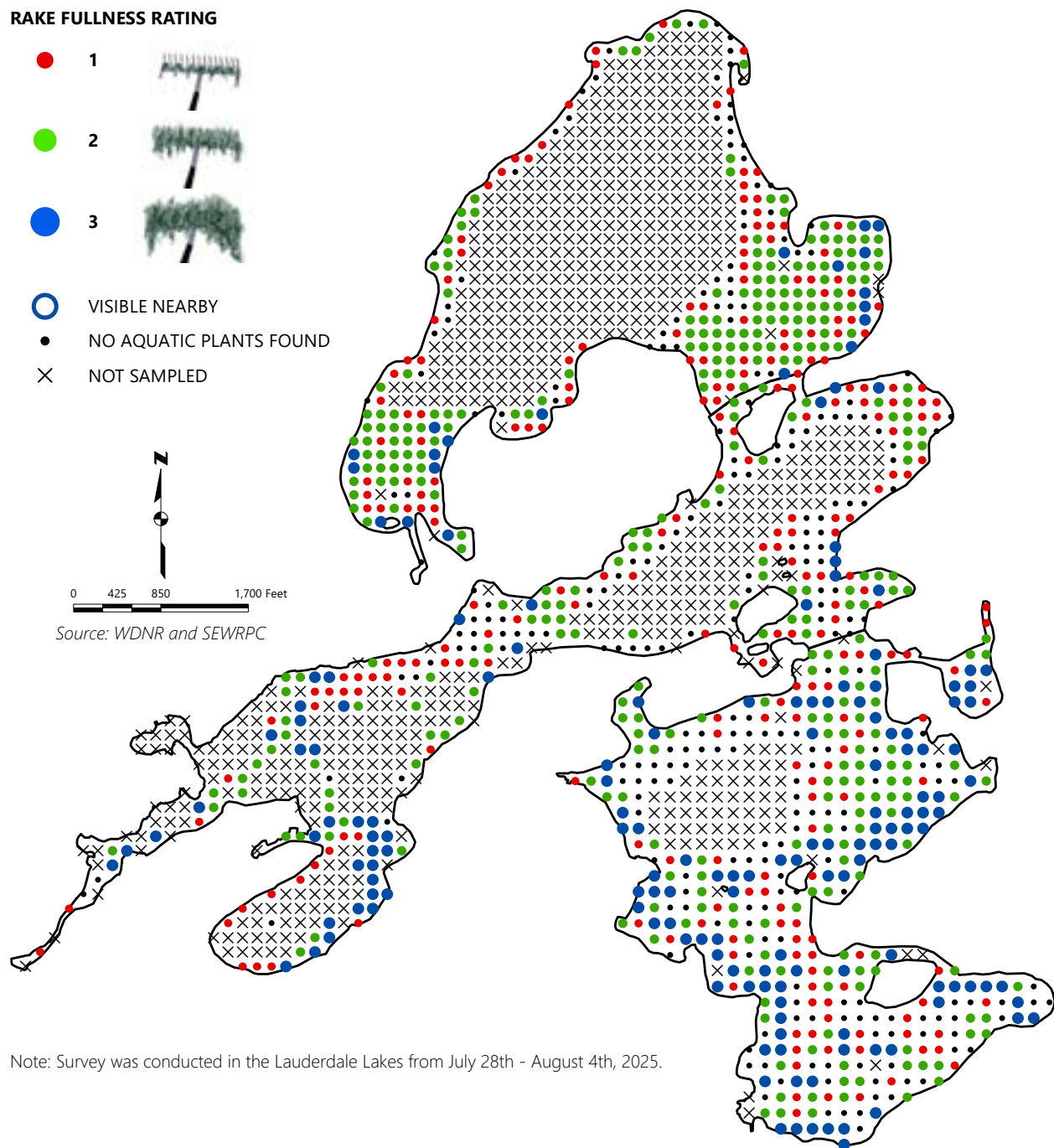


Table 2.5
Lauderdale Lakes Aquatic Plants Summary Statistics: PI Survey 2025

Statistic	Green Lake	Middle Lake	Mill Lake
Total number of sites visited	312	304	409
Total number of sites on PI grid	708	600	471
Total number of sites with vegetation	254	217	295
Total number of sites shallower than maximum depth of plants	301	288	380
Frequency of occurrence at sites shallower than maximum depth of plants	84.39	75.35	77.63
Simpson Diversity Index	0.79	0.77	0.84
Maximum depth of colonization (feet)	18.00	12.00	13.00
Number of sites sampled using rake on Rope (R)	39	17	36
Number of sites sampled using rake on Pole (P)	273	287	373
Average number of all species per site (shallower than max depth)	1.90	1.44	1.94
Average number of all species per site (vegetation sites only)	2.25	1.90	2.49
Average number of native species per site (shallower than max depth)	1.60	1.30	1.70
Average number of native species per site (vegetation sites only)	1.94	1.77	2.22
Species Richness	18	29	21
Species Richness (including visuals)	22	32	25

Source: SEWRPC

Maximum Depth of Colonization

Maximum depth of colonization (MDC) can be a useful indicator of water quality, as turbid and/or eutrophic (nutrient-rich) lakes generally have shallower MDC than lakes with clear water.²⁶ It is important to note that for surveys using the point-intercept protocol, the protocol allows sampling to be discontinued at depths greater than the maximum depth of colonization for vascular plants. However, aquatic moss and macroalgae, such as muskgrass and nitella, frequently colonize deeper than vascular plants and thus may be under-sampled in some lakes. For example, *Chara globularis* and *Nitella flexilis* have been found growing as deep as 37 and 35 feet, respectively, in Silver Lake, in Washington County. The MDC in 2025 in Green Lake was 18 feet, 4.5 feet deeper than in the 2019 survey (see Table 2.5). The most common plants seen in depths 14 feet or greater included muskgrass (*Chara* spp.) and spiny naiad (*Najas marina*). Both Middle and Mill Lakes had a slight decrease in MDC from 2019 to 2025. The MDC of Middle Lake was 12 feet in 2025, decreasing a foot from the 2019 survey. Likewise, the MDC of Mill Lake was 13 feet in 2025, decreasing a half-foot from 2019.

Species Richness

The number of distinct types of aquatic plants present in a lake is referred to as the species richness of the lake. Larger lakes with diverse lake basin morphology, less human disturbance, and/or healthier, more resilient lake ecosystems have greater species richness. All three lakes saw an increase of species richness from the 2019 to 2025 surveys. Including visual sightings of aquatic plants, species richness increased in Green Lake from 19 species in 2019 to 22 species in 2025 (see Table 2.2). The species richness of Middle Lake increased from 27 species in 2019 to 32 species in 2025 (see Table 2.3). Additionally, the species richness of Mill Lake increased from 22 species in 2019 to 25 species in 2025 (see Table 2.4).

In 1967, only 11 species of aquatic plants were found in the Lauderdale Lakes and the number of species shows an overall upward trend in surveys since (see Table 2.2, Table 2.3, and Table 2.4). While this is a good trend to see, it should be noted that over the years the methodology for plant surveys and taxonomy identification has improved, which may have contributed to the increase in known species. Some areas of the Lake, particularly the western portion of Middle Lake, may have been more thoroughly surveyed this year than in previous years due to having a smaller watercraft that could access these shallow areas more easily without disturbing habitat.

²⁶ Canfield Jr D.E., Langeland L., and Haller W.T., "Relations Between Water Transparency and Maximum Depth of Macrophyte Colonization in Lakes," Journal of Aquatic Plant Management 23, 1985.

Biodiversity and Species Distribution

Species richness is often incorrectly used as a synonym for biodiversity. The difference in meaning between these terms is both subtle and significant. Biodiversity is based on the number of species present in a habitat along with the abundance of each species. For the purposes of this study, abundance was determined as the percentage of observations of each species compared to the total number of observations made. Aquatic plant biodiversity can be measured with the Simpson Diversity Index (SDI).²⁷ Using this measure, a community dominated by one or two species would be considered less diverse than one in which several different species have similar abundance. In general, more diverse biological communities are better able to maintain ecological integrity in response to environmental stresses. Promoting biodiversity not only helps sustain an ecosystem but preserves the spectrum of options useful for future management decisions.

In 2025, Green Lake's SDI score was 0.79, a decrease from the Lake's 2019 SDI of 0.83 (see Table 2.5). The 2025 survey found between zero and eight species at any single sampling point across the Lake, with higher species richness in the shallow bays on the southeast and southwest ends of the Lake (Figure 2.5). Middle Lake's SDI slightly decreased from 0.82 in 2019 to 0.79 in 2025, and up to seven species were found at any single point. Species richness was generally higher on the eastern lobe of Middle Lake. Mill Lake's SDI increased from 0.83 in 2019 to 0.84 in 2025, and up to nine different species were observed on the lake at a given point. Species richness distribution in the 2025 survey in Mill Lake was generally higher in the shallow bays, including Don Jean Bay. Actions that can conserve and promote aquatic plant biodiversity are critical to the long-term health of the Lauderdale Lakes. Such actions not only help sustain and increase the robustness and resilience of the existing ecosystem but also promote efficient and effective future conservation management.

Sensitive Species

Aquatic plant metrics such as species richness and the floristic quality index (FQI), can be useful for evaluating lake health. In hard water lakes, such as those common in Southeastern Wisconsin, species richness generally increases with water clarity and decreases with nutrient enrichment.²⁸ The FQI is an assessment metric used to evaluate how closely a lake's aquatic plant community matches that of undisturbed, pre-settlement conditions.²⁹ To formulate this metric, Wisconsin aquatic plant species were assigned conservatism (C) values on a scale from zero to ten that reflect the likelihood that each species occurs in undisturbed habitat. These values were assigned based on the species substrate preference, tolerance of water turbidity, water drawdown tolerance, rooting strength, and primary reproductive means. Native "sensitive" species that are intolerant of ecological disturbance receive high C values, while natives that are disturbance tolerant receive low C values. Invasive species are assigned a C value of 0. A lake's FQI is calculated as the average C value of species identified in the lake, divided by the square root of species richness.

In the 2025 survey, the FQI's of Green, Middle, and Mill Lakes were 22.2, 30.2, and 23.5, respectively. Compared to the 2019 survey, Green and Mill Lakes had slight decreases in FQI scores (score decreases of 1.1 and 0.8, respectively), though Middle Lake's FQI score increased by 6.7. The substantial increase in the FQI score can most likely be attributed to the fact that Commission staff were able to survey more points in the western channels in sensitive area 3 (see Map 2.1) in 2025 than in the 2019 survey due to canoe access; this allowed navigation in shallow, narrow areas previously impossible to survey with larger boats. In regard to the changes in the Lauderdale Lakes FQI scores, it is noteworthy to mention that plant communities naturally fluctuate based on many different factors; slight changes in FQI may be reflective of these fluctuations rather than a persistent trend in the aquatic plant community. Both the 2019 and 2025 surveys of the Lauderdale Lakes had FQI values that are higher than average for the Southeastern Wisconsin Till Plains ecoregion of 20.0, indicating that these Lakes have stable and healthy aquatic plant communities.

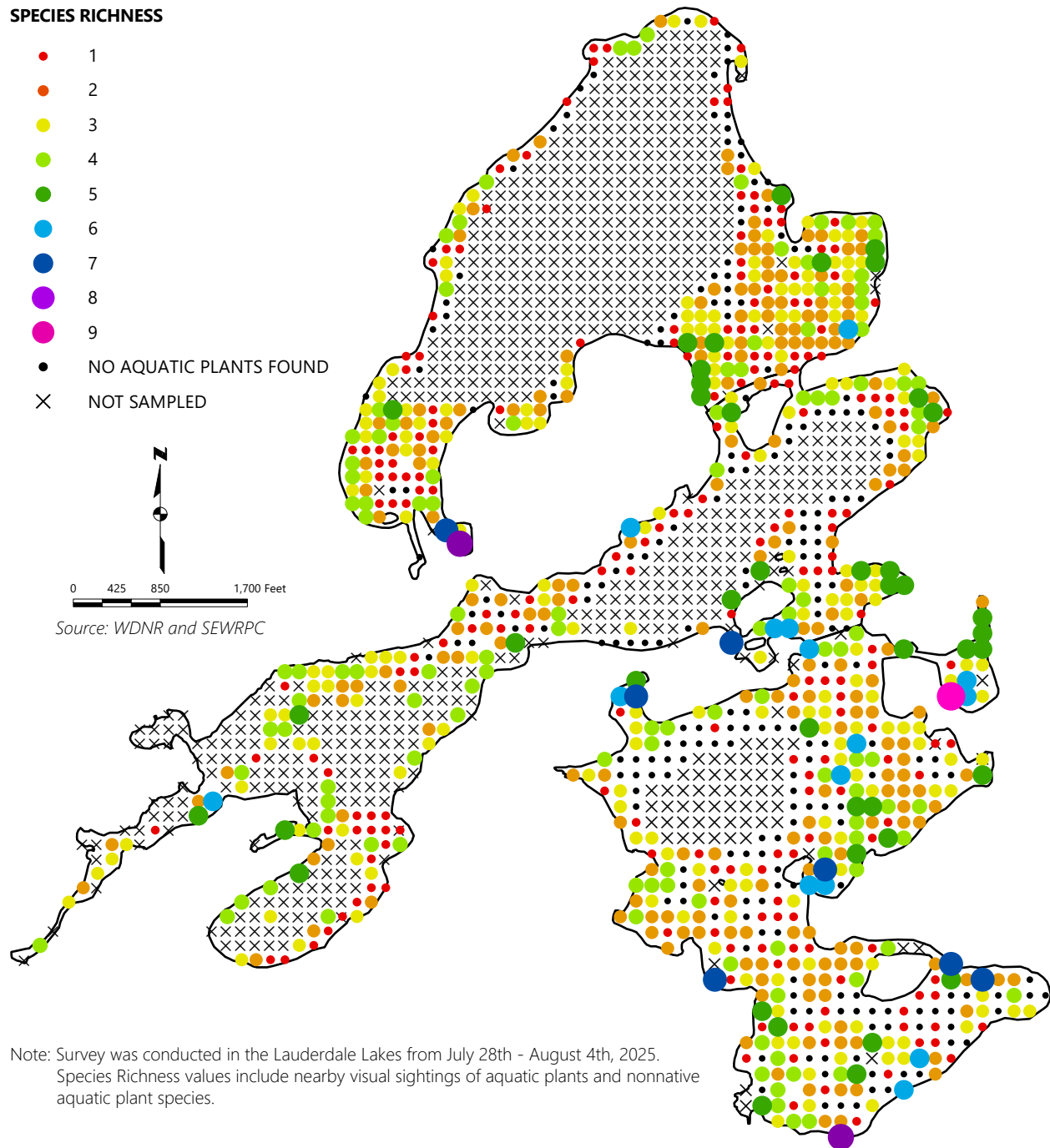
FQI scores are but one metric in assessing aquatic plant communities. Other aquatic plants metrics, such as species richness and disturbance tolerance, are often used as indicators of the ecological health of a lake due to aquatic plants' varying sensitivity to human activity. In hard water lakes, such as those common in

²⁷ *The SDI expresses values on a zero to one scale where 0 equates to no diversity and 1 equates to infinite diversity.*

²⁸ Vestergaard, O. and Sand-Jensen, K. "Alkalinity and Trophic State Regulate Aquatic Plant Distribution in Danish Lakes," *Aquatic Botany* 67, 2000.

²⁹ S. Nichols, "Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications," *Lake and Reservoir Management* 15(2), 1999.

Figure 2.5
Species Richness in the Lauderdale Lakes: Summer 2025



Southeastern Wisconsin, species richness generally increases with water quality and decreases with nutrient enrichment.³⁰ Beginning with the 2024 impairment listing cycle, WDNR began utilizing a model developed to assess lake health from a study published in 2017 by Mikulyuk et al.³¹ This model evaluates whether a lake has been disturbed by human activity using known species sensitivity to disturbance as well as the littoral frequency of occurrence of each species observed on the lake.³² Two sensitive species, as identified in this 2017 publication, were found in Green Lake during the 2025 survey: slender naiad (*Najas flexilis*) and variable pondweed (*Potamogeton gramineus*). Middle Lake was found to have six sensitive species: slender naiad (*Najas flexilis*), Southern naiad (*Najas guadalupensis*), nitella (*Nitella* sp.), variable pondweed (*Potamogeton gramineus*), creeping bladderwort (*Utricularia gibba*), and small bladderwort (*Utricularia minor*). Mill Lake had four sensitive species: slender naiad (*Najas flexilis*), southern naiad (*Najas guadalupensis*), large-leaf pondweed (*Potamogeton amplifolius*), and variable pondweed (*Potamogeton gramineus*). The number of sensitive species identified at each survey point are shown in Figure 2.6.

Although the Mikulyuk et al. study provides the latest research in sensitive species identification, used for regulatory purposes and in this report, other aforementioned factors such as high C values of species (typically seven or greater) can also be indicative of good water quality and less disturbed aquatic habitat. In the 2025 survey, the average C values of Green, Middle, and Mill Lakes were 5.9, 6.2, and 5.9, respectively. Aquatic plant species with C values of 7 or greater can be seen in Table 2.6. Of note, small bur-reed (*Sparganium natans*), with a C value of 9, was observed in Middle Lake in the 2025 survey. This species is found in only one other southeastern Wisconsin lake, Eagle Spring Lake, making it a regionally uncommon species.³³ When assessing aquatic plant communities, using multiple methods of evaluation are helpful to understand species values and roles.

Relative Species Abundance

Based on the 2025 point-intercept survey, the five most abundant aquatic plant species found in Green Lake were, in decreasing order of abundance: 1) muskgrass, 2) Sago pondweed, 3) spiny naiad, 4) eelgrass, and 5) slender naiad. The five most abundant aquatic plant species in Middle Lake were, in decreasing order of abundance: 1) muskgrass, 2) eelgrass, 3) Sago pondweed, 4) spiny naiad, and 5) common bladderwort. Finally, in Mill Lake, the five most abundant species were, in decreasing order of abundance: 1) muskgrass, 2) eelgrass, 3) common waterweed and spiny naiad (tie), 4) common bladderwort and Eurasian watermilfoil (tie), and 5) Sago pondweed. Figures of these common species can be seen in Appendix A.

Muskgrass (*Chara* sp.), a type of macroalgae, has continuously been amongst the most observed species in the Lake. This is a critical group of species to protect, as muskgrass has been found to promote marl formation and induce dissolved phosphorus to be precipitated to the lake bottom, reducing phosphorus concentrations in the water column and thus improving water clarity.³⁴ Additionally, muskgrass is a favorite waterfowl food and helps stabilize lake-bottom sediment, as it has been observed to grow deeper than most vascular plants. Its prevalence in a lake's aquatic plant community may tangibly contribute to lake water quality, promoting the growth of other desirable native plant species.

Other consistently abundant aquatic plant species include eelgrass and Sago pondweed. Both species provide food and habitat for fish, aiding in maintaining healthy populations (see Table 2.1). Furthermore, eelgrass supports insect habitat and breeding that sustains the macroinvertebrates and fishes higher in the food chain, while Sago pondweed provides a food source for waterfowl. These common aquatic plants provide many services to support the aquatic ecosystem.

³⁰ Vestergaard and Sand-Jensen, 2000, op. cit.

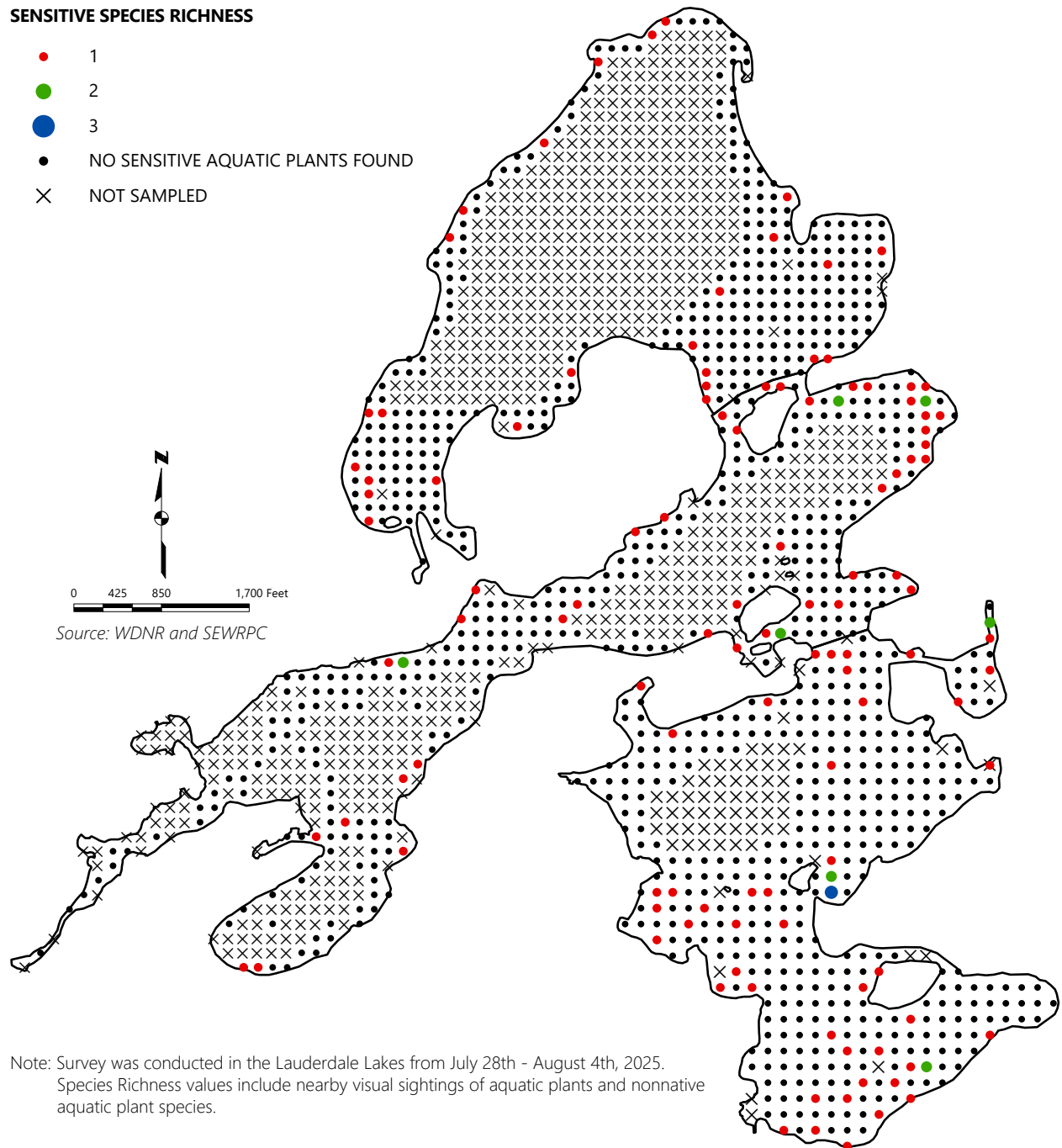
³¹ A. Mikulyuk, M. Barton, J. Hauxwell, C. Hein, E. Kujawa, K. Minahan, M.E. Nault, D.L. Oele, and K.I. Wagner, "A macrophyte bioassessment approach linking taxon-specific tolerance and abundance in north temperate lakes," Journal of Environmental Management 199 (2017): 172-180.

³² Disturbance variables in the model included the lake's nutrient status, specific conductance (a proxy measurement for salt concentrations), and the amount of developed land use (e.g., agriculture, roads, urban lands) within the lake's watershed.

³³ dnr-wisconsin.shinyapps.io/AquaticPlantExplorer.

³⁴ M. Scheffer and E.H. van Ness, "Shallow Lakes Theory Revisited: Various Alternative Regimes Driven by Climate, Nutrient, Depth, and Lake Size," Hydrobiologia 584, 2007.

Figure 2.6
Sensitive Species Richness in the Lauderdale Lakes: Summer 2025



Invasive Species

This subsection will discuss invasive species observations in the Lauderdale Lakes, as these are often the focus of aquatic plant management efforts.

Starry Stonewort

Nitellopsis obtusa, known as starry stonewort (SSW) is a novel aquatic invasive macroalga species in Wisconsin. As a member of the Characeae, SSW is related to native *Chara*, *Lychnothamnus*, *Nitella*, and *Tolypella* species, which have roughly similar characteristics and are found in many hardwater lakes across Wisconsin. Native to Eurasia, the first discovery of SSW in North America was in the St. Lawrence Seaway in 1978; it has since spread to several northeastern and midwestern US states as well as southern Ontario.³⁵ First observed within Wisconsin in Little Muskego Lake during September 2014, SSW has since been found in 28 lakes in southeastern Wisconsin at the time of this report.³⁶ Within Walworth County, SSW has been observed in Geneva Lake, Pleasant Lake, and Lake Beulah.

In its native range, SSW has been shown to provide food and habitat for aquatic organisms as well as enhance lake water quality by reducing sediment suspension and acting as a phosphorus sink.³⁷ In invaded lakes, SSW can form dense beds, with reported maximum heights of 4 to 7 feet, outcompete both native and other invasive plant species, and cover fish spawning areas.^{38,39,40} This species is capable of both sexual and asexual reproduction, which can occur through plant fragments as well as the star-shaped bulbils for which the species is named.⁴¹ Only male species have been observed in North America thus far, indicating that all spread has been through asexual reproduction. Bulbils may stay viable in lake sediment for several years, making it extremely difficult to eradicate SSW from a waterbody.

Commission staff made the first ever observations of SSW on the Lauderdale Lakes during the 2025 survey. Photographs and vouchers of SSW were collected by Commission staff and provided to Patrick Siwula, the WDNR Southeast Region Aquatic Invasive Species Biologist. In Green Lake, SSW was observed near the Westshore Drive boat launch as well as near the channel to Middle Lake (see Figure 2.7). The SSW near the launch was predominantly intermixed with native plants and was found at depths up to 10.5 feet. Isolated colonies were observed around the passageway from Green Lake to Middle Lake. Only one PI point in Green Lake, point 42, had a monocultural colony of SSW (rake fullness of 2.0); however, Commission staff did observe a shallow monocultural population in the channel near the Westshore Drive launch that was not at a designated PI point. Overall, SSW was found at 3.6 percent of vegetated areas with an average rake fullness of 1.2 in Green Lake.

Table 2.6
Aquatic Plant Species Observed
in the Lauderdale Lakes with
C Values of 7 or Greater

Aquatic Plant Species	C Value ^{a,b}
<i>Chara</i> spp. (muskgrass)	7
<i>Najas guadalupensis</i> (southern naiad)	8
<i>Nitella</i> spp. (stonewort)	7
<i>Potamogeton friesii</i> (Fries' pondweed)	8
<i>Potamogeton gramineus</i> (variable pondweed)	7
<i>Ranunculus aquatilis</i> (white water crowfoot)	8
<i>Sagittaria cuneata</i> (arrow-leaved arrowhead)	7
<i>Sparganium natans</i> (small bur-reed)	9
<i>Utricularia minor</i> (small bladderwort)	10
<i>Utricularia vulgaris</i> (common bladderwort)	7
<i>Zizania</i> sp. (wild rice)	8

^a Nichols, S.A. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. *Journal of Lake and Reservoir Management*, 15(2): 133-141. 1999.

^b Bernthal et al. "Development of a Floristic Quality Assessment Methodology for Wisconsin," 2003.

Source: Stantec, WDNR, and SEWRPC

³⁵ starrystonewort.org/maps.

³⁶ apps.dnr.wi.gov/lakes/invasives/AISLists.aspx?species=STARRY_STONEW.

³⁷ For a more complete review of SSW ecology in its native and invasive range, see D.J. Larkin, A.K. Monfils, A. Boissezon, R.S. Sleith, P.M. Skawinski, C.H. Welling, B.C. Cahill, and K.G. Karol, "Biology, Ecology, and Management of Starry Stonewort (*Nitellopsis obtusa*; Characeae): A Red-listed Eurasian Green Alga Invasive in North America," *Aquatic Botany* 148: 15-24, 2018 as well as *State of Michigan, Status and Strategy for Starry Stonewort (*Nitellopsis obtusa* (Desv. In Loisel.) J. Groves) Management, last updated December 2017* (www.michigan.gov/documents/invasives/egle-ais-nitellopsis-obtusa-strategy_708937_7.pdf).

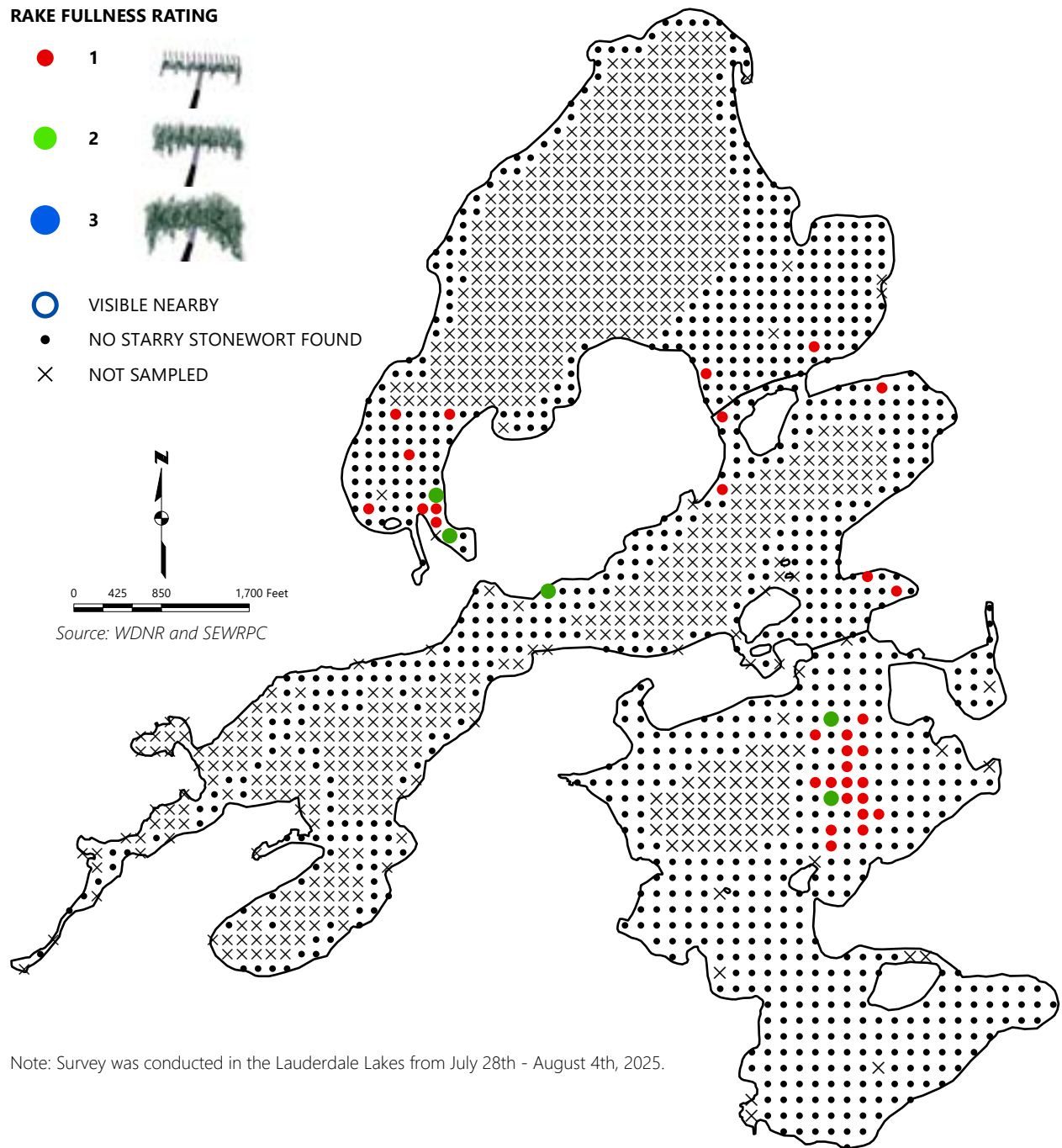
³⁸ Ibid.

³⁹ dnr.wisconsin.gov/sites/default/files/topic/Invasives/Nitellopsis%20obtusa.pdf.

⁴⁰ G.D. Pullman and G. Crawford, "A Decade of Starry Stonewort in Michigan," *Lakeline* 36-42, 2010.

⁴¹ dnr.wisconsin.gov/topic/Invasives/fact/StarryStonewort.html.

Figure 2.7
Starry Stonewort Total Rake Fullness in the Lauderdale Lakes: Summer 2025



In Middle Lake, SSW populations were dispersed across nearshore areas and intermixed with native species. At the time of the 2025 survey, all SSW populations in Middle Lake were located on the eastern half of the Lake with no SSW found in any WDNR-designated Sensitive Areas of Middle Lake. Overall, SSW was found in 2.8 percent of vegetated areas with an average rake fullness of 1.2 in Middle Lake.

Mill Lake had the highest population of SSW, singularly located in a north-south running swath in the northeast lobe of the Lake. It was found at depths up to 13 feet, largely cohabitating with native species, though two PI points had small monocultural communities (point 169 and point 142, both had a rake fullness of 1.0). Throughout Mill Lake, SSW was found in 6.4 percent of vegetated areas with an average rake fullness of 1.1.

Based on the distribution of SSW across all three lakes, it seems likely that SSW was introduced first to Green Lake via the Westshore Drive boat launch and subsequently spread to Middle and Mill lakes via boat traffic. There was no SSW observed near the other public or private launches on the Lake, which would seemingly rule these out as introduction points. Although there is extensive open lake sediment that SSW could potentially colonize (particularly in the channels between the lakes), the SSW is still fairly limited within the lakes which may indicate a relatively recent introduction especially as SSW was not observed during the 2019 survey. These channels have high and fast-moving boat traffic, particularly the channel between Middle and Mill Lake as it is not slow-no-wake, which may limit the ability of both native and invasive aquatic plants to establish in these areas.

Curly-Leaf Pondweed

Curly-leaf pondweed (CLP), like Eurasian watermilfoil, is identified in Chapter NR 109 of the Wisconsin Administrative Code as a nonnative invasive aquatic plant. Although survey data suggests it presently is only a relatively minor species in terms of dominance, and, as such, is less likely to interfere with recreational boating activities, the plant can grow dense strands that exclude other high value aquatic plants. For this reason, curly-leaf pondweed must continue to be monitored and managed as an invasive member of the aquatic community. Lastly, it must be remembered that curly-leaf pondweed senesces by midsummer and therefore may be underrepresented in the inventory data presented in this report.

During the 2025 survey of Green Lake, Commission staff did not find CLP on the rake at any points across the Lake (see Figures 2.8 and 2.9). It was, however, seen as a visual observation at single point at the eastern end of the Lake near the Lauderdale Shores private boat launch. CLP occurred at 0.5 percent of vegetated points in the 2025 survey of Green Lake, a decrease from 0.9 percent of points in 2019. In Middle Lake, CLP was only observed at two points: in a small bay near the Lauderdale Landing restaurant and on the eastern shore near the Middle to Mill Lake channel. The average rake fullness also decreased during this time from 1.5 in 2019 to 1.0 in 2025, suggesting populations of CLP overall decreased in Middle Lake between the surveys. Lastly, in Mill Lake, CLP was found at 1.7 percent of vegetated points in 2025 with an average rake fullness of 1.0. CLP was not found on the rake in Mill Lake in the 2019 survey but was seen as a visual observation near three PI points.

Spiny Naiad

Spiny naiad is native to North America but was introduced to, and has become naturalized in, Wisconsin. It is a restricted species in Wisconsin and is therefore identified as an established invasive species that has the potential to cause significant environmental or economic harm.⁴² However, the species is reported to be used as a food source for waterfowl, marsh birds, muskrat, and shelter/forage area for fish. Spiny naiad is abundant in all three Lakes, though populations fluctuated in the time period between the 2019 and the 2025 surveys (see Figures 2.10 and 2.11).

In Green Lake, spiny naiad was found at 28.9 percent of vegetated areas compared to 17.9 percent in 2019. Rake fullness also increased from 1.0 in 2019 to 1.2 in 2025. In Middle Lake, spiny naiad was found at 13.4 percent of vegetated areas, compared to 25.7 percent in 2019. Additionally, rake fullness decreased from 1.3 in 2019 to 1.2 in 2025. In Mill Lake, spiny naiad occurred at 17 percent of vegetated areas, a decrease from the 19 percent of vegetated areas found in 2019. However, the average total rake fullness

⁴² Wisconsin Department of Natural Resources, Chapter NR 40, *Invasive Species Identification, Classification and Control*, April 2017.

Figure 2.8
Curly-Leaf Pondweed Rake Fullness in the Lauderdale Lakes: Summer 2025

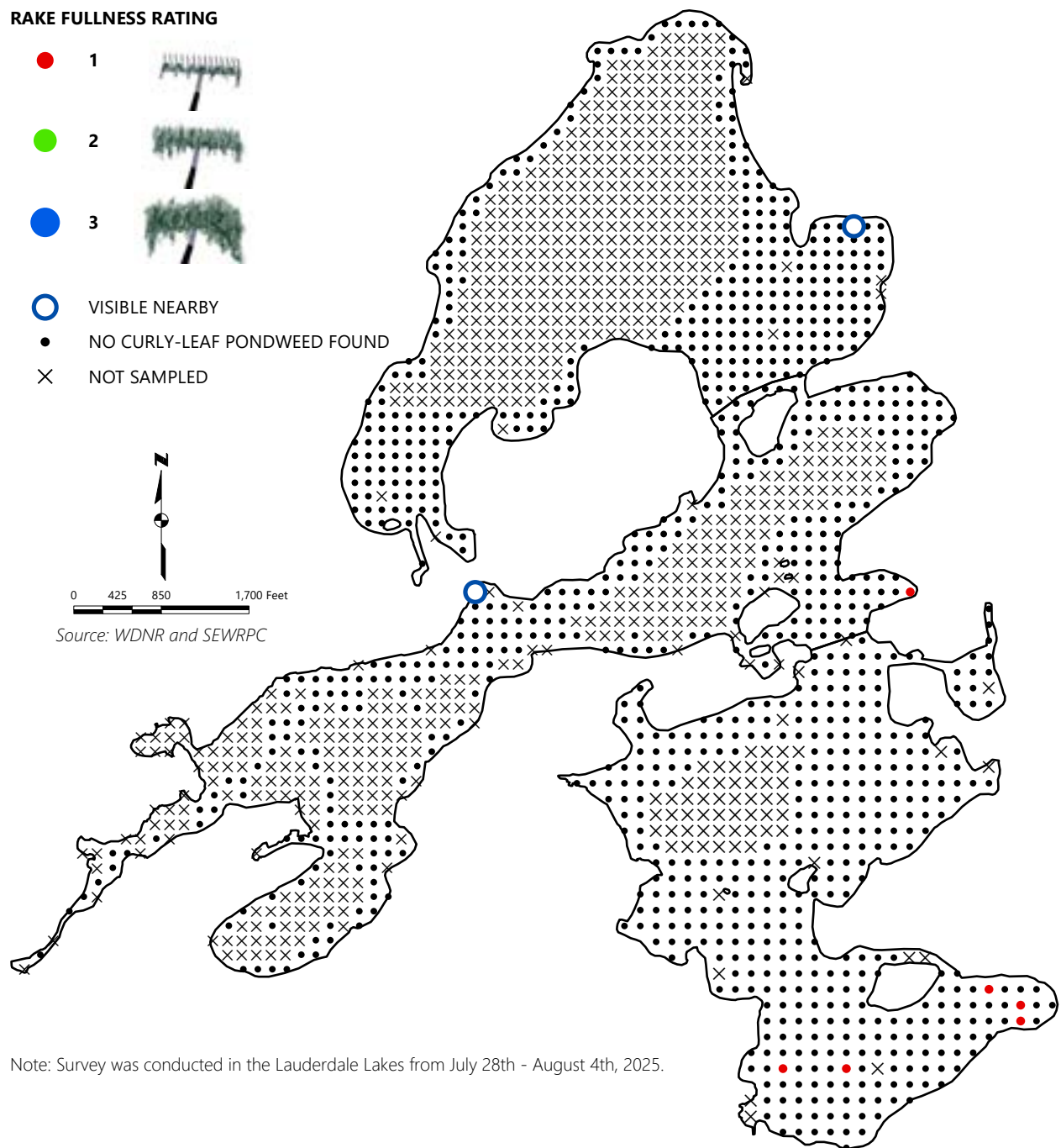


Figure 2.9
Change in Curly-Leaf Pondweed Rake Fullness in the Lauderdale Lakes: 2019-2025

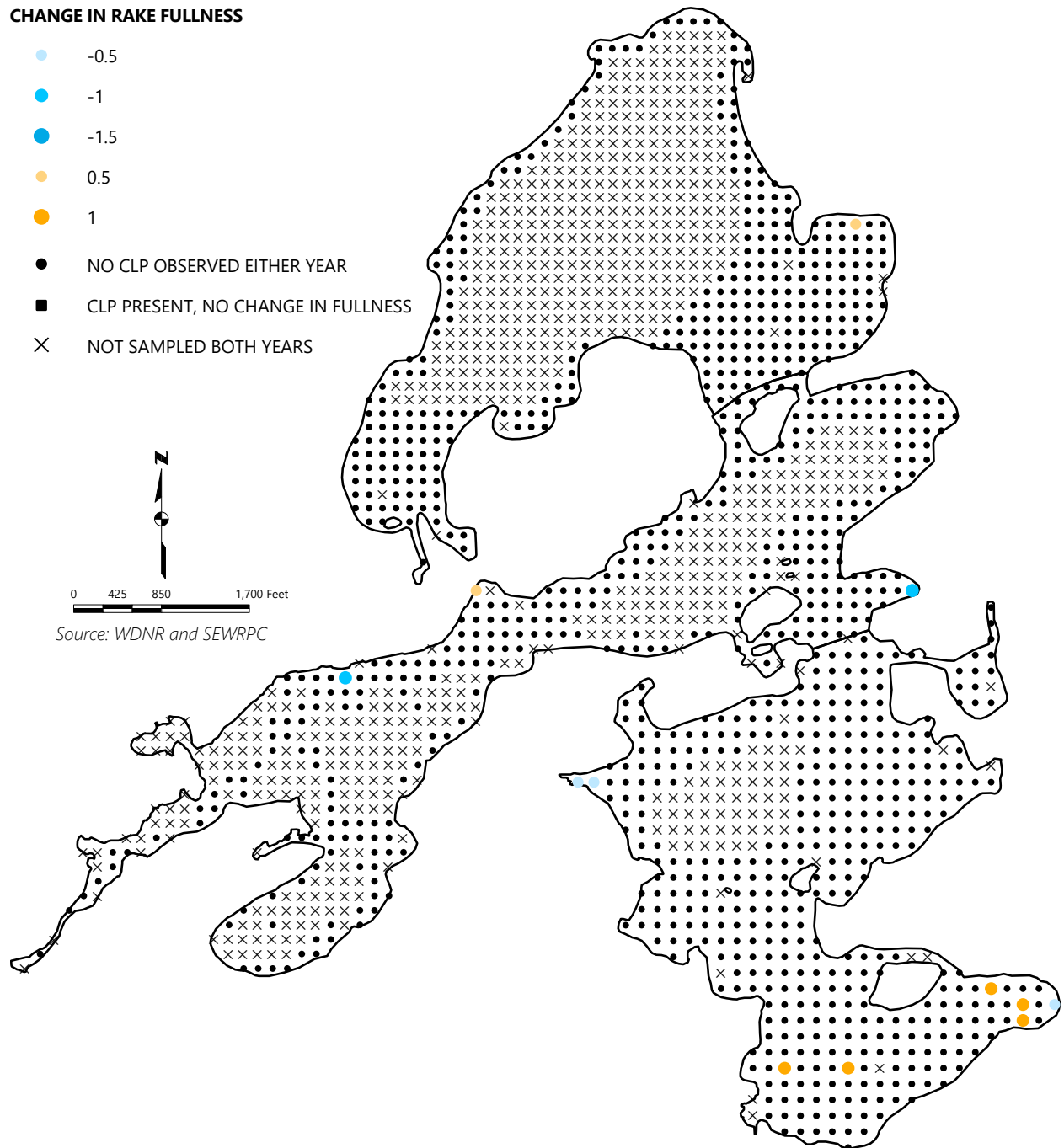


Figure 2.10
Spiny Naiad Rake Fullness in the Lauderdale Lakes: Summer 2025

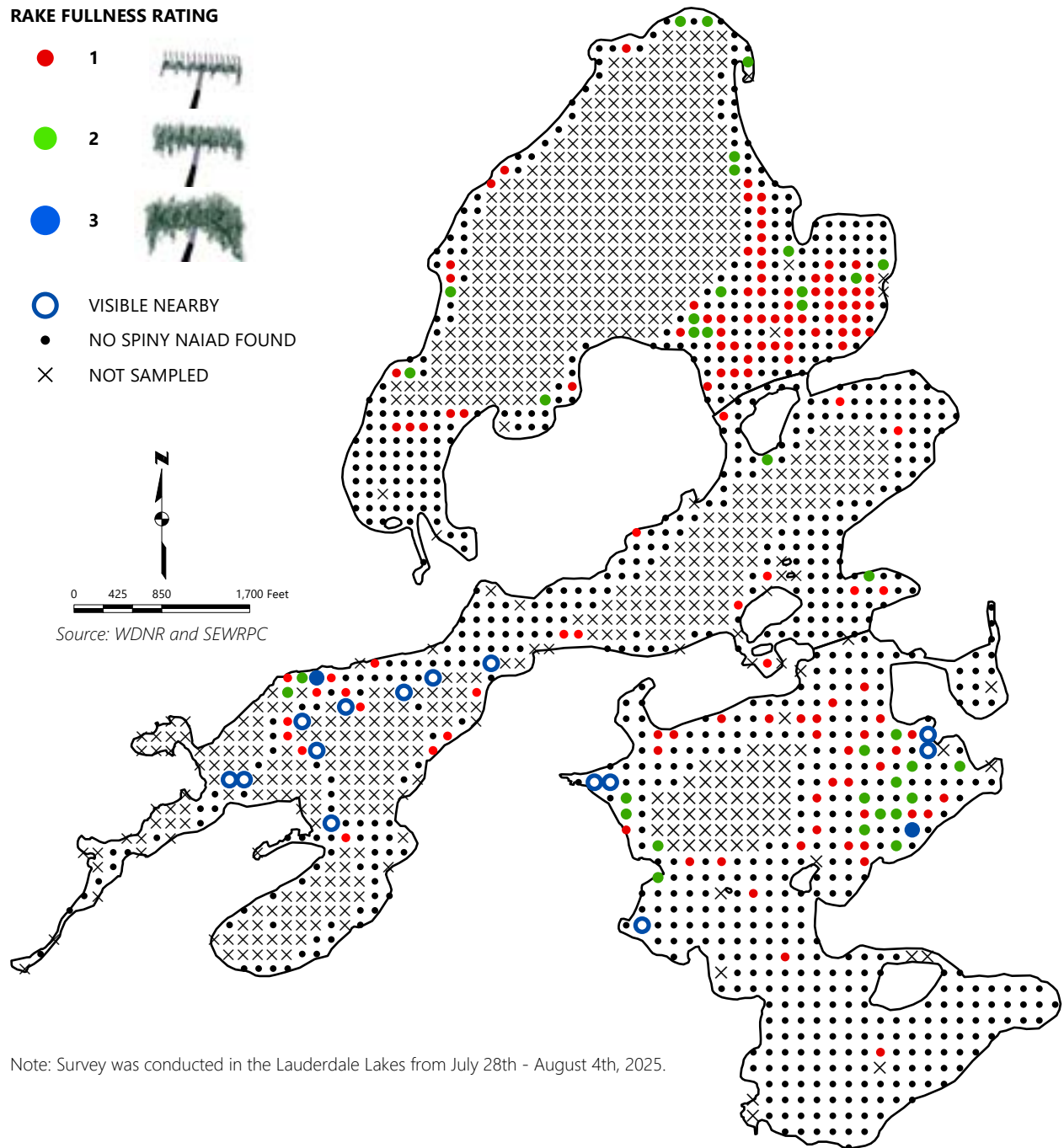
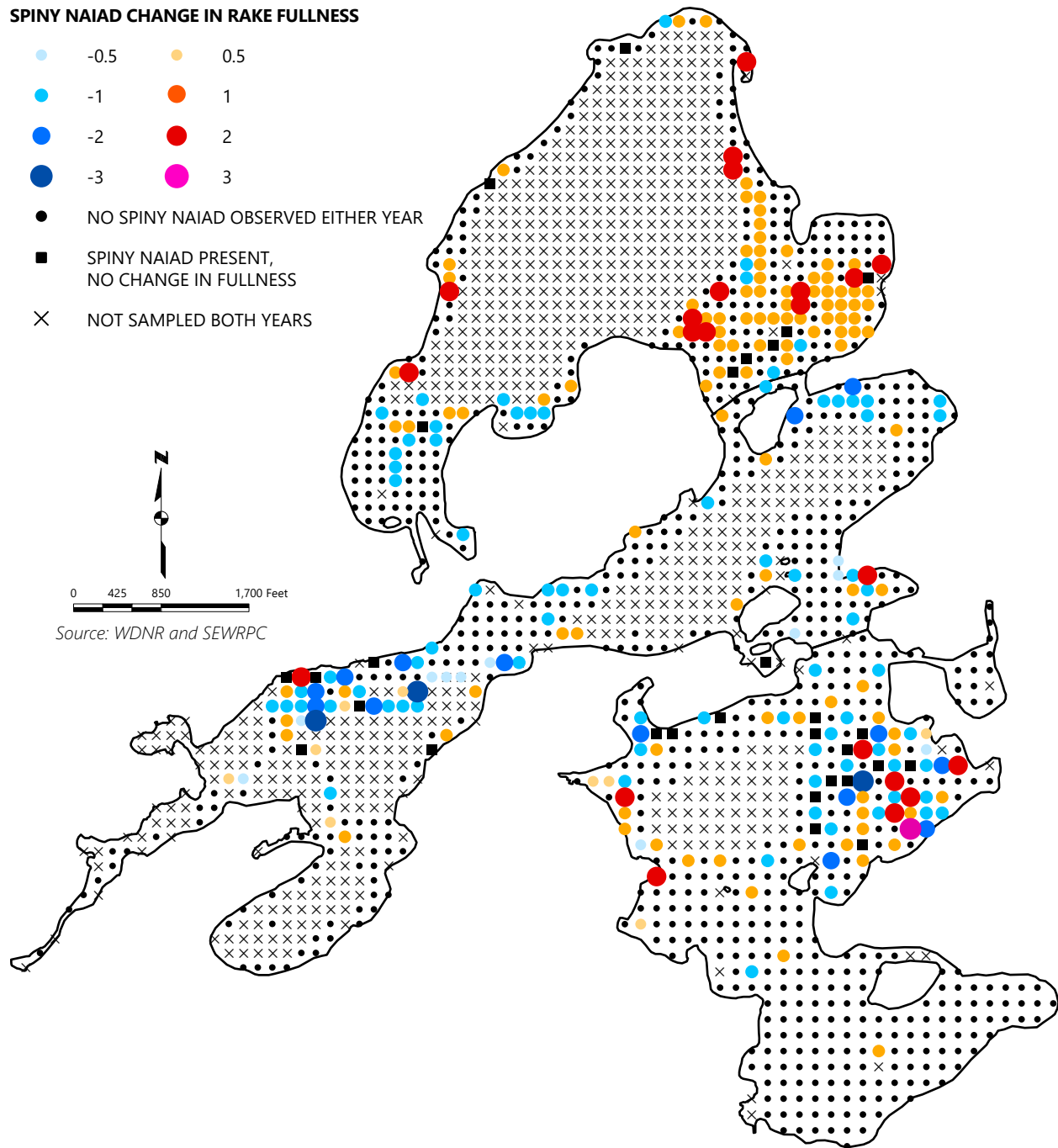


Figure 2.11
Change in Spiny Naiad Rake Fullness in the Lauderdale Lakes: 2019-2025



increased from 1.25 in 2019 to 1.3 in 2025.

Eurasian Watermilfoil

Eurasian watermilfoil (EWM) is one of eight milfoil species found in Wisconsin and is the only exotic or nonnative milfoil species. EWM favors mesotrophic to moderately eutrophic waters, fine organic-rich lake-bottom sediment, warmer water with moderate clarity and high alkalinity, and tolerates a wide range of pH and salinity.^{43,44} In southeastern Wisconsin, EWM can grow rapidly and has few natural enemies to inhibit its growth. Furthermore, it can grow explosively following major environmental disruptions, as small fragments of EWM can grow into entirely new plants.⁴⁵ For reasons such as these, EWM can grow to dominate an aquatic plant community in as little as two years.^{46,47} In such cases, EWM can displace native plant species and interfere with the aesthetic and recreational use of waterbodies. However, established populations may rapidly decline after approximately ten to 15 years.⁴⁸

Human-produced EWM fragments (e.g., created by boating through EWM), as well as fragments generated from natural processes (e.g., wind-induced turbulence, animal feeding/disturbance) readily colonize disturbed sites, contributing to EWM spread. EWM fragments can remain buoyant for two to three days in summer and two to six days in fall, with larger fragments remaining buoyant longer than smaller ones.⁴⁹ The fragments can also cling to boats, trailers, motors, and/or bait buckets where they can remain alive for weeks contributing to transfer of milfoil to other lakes. For these reasons, it is especially important to remove all vegetation from boats, trailers, and other equipment after removing them from the water and prior to launching in other waterbodies. EWM has been one of the District's primary targets for control through its ongoing aquatic plant management program. Additionally, riparian landowners also direct substantial effort to EWM control. The sustained and targeted efforts in decreasing EWM were apparent in the 2025 survey. The combination of these efforts over time may be decreasing EWM abundance.

EWM was observed at 1.6 percent of vegetated points in Green Lake during 2025, and 14.2 percent in 2019. The EWM population appears to have substantially decreased, as seen in decreased rake fullness as well (down from 1.1 in 2019 to 1.0 in 2025). The four points at which EWM was found in Green Lake were in shallow nearshore bays in the southwest and northeast of the Lake where the highest density populations were seen in 2019 (see Figures 2.12 and 2.13).

Similarly, EWM populations decreased in Middle Lake from the 2019 to the 2025 survey, as it was observed at 4.2 percent of vegetated areas in 2025, compared to 9.2 percent in 2019. The average rake fullness stayed the same at 1.0 for both years. The highest populations were seen in the nearshore areas in the southwest of the Lake.

EWM was seen in the highest populations in Mill Lake, occurring at 12.2 percent of vegetated points in the 2025 survey. However, Mill Lake also had the largest decrease in EWM, as it was previously found at 47.4 percent of vegetated points in 2019. Rake fullness also decreased from 1.3 in 2019 to 1.1 in 2025. Current populations of EWM based on the 2025 survey appear to be in Don Jean Bay as well as the most northeast area of the Lake.

⁴³ U.S. Forest Service, *Pacific Islands Ecosystems at Risk (PIER)*, 2019.: hear.org/pier/species/myriophyllum_spicatum.htm.

⁴⁴ S.A. Nichols and B. H. Shaw, "Ecological Life Histories of the Three Aquatic Nuisance Plants: *Myriophyllum spicatum*, *Potamogeton crispus*, and *Elodea canadensis*," *Hydrobiologia* 131(1), 1986.

⁴⁵ Ibid.

⁴⁶ S.R. Carpenter, "The Decline of *Myriophyllum spicatum* in Eutrophic Wisconsin (USA) Lake," *Canadian Journal of Botany* 58(5), 1980.

⁴⁷ Les, D. H., and L. J. Mehrhoff, "Introduction of Nonindigenous Vascular Plants in Southern New England: a Historical Perspective," *Biological Invasions* 1:284-300, 1999.

⁴⁸ S.R. Carpenter, 1980, op. cit.

⁴⁹ J.D. Wood and M. D. Netherland, "How Long Do Shoot Fragments of *Hydrilla* (*Hydrilla verticillata*) and Eurasian Watermilfoil (*Myriophyllum spicatum*) Remain Buoyant?," *Journal of Aquatic Plant Management* 55: 76-82, 2017.

Figure 2.12
Eurasian Watermilfoil Rake Fullness in the Lauderdale Lakes: Summer 2025

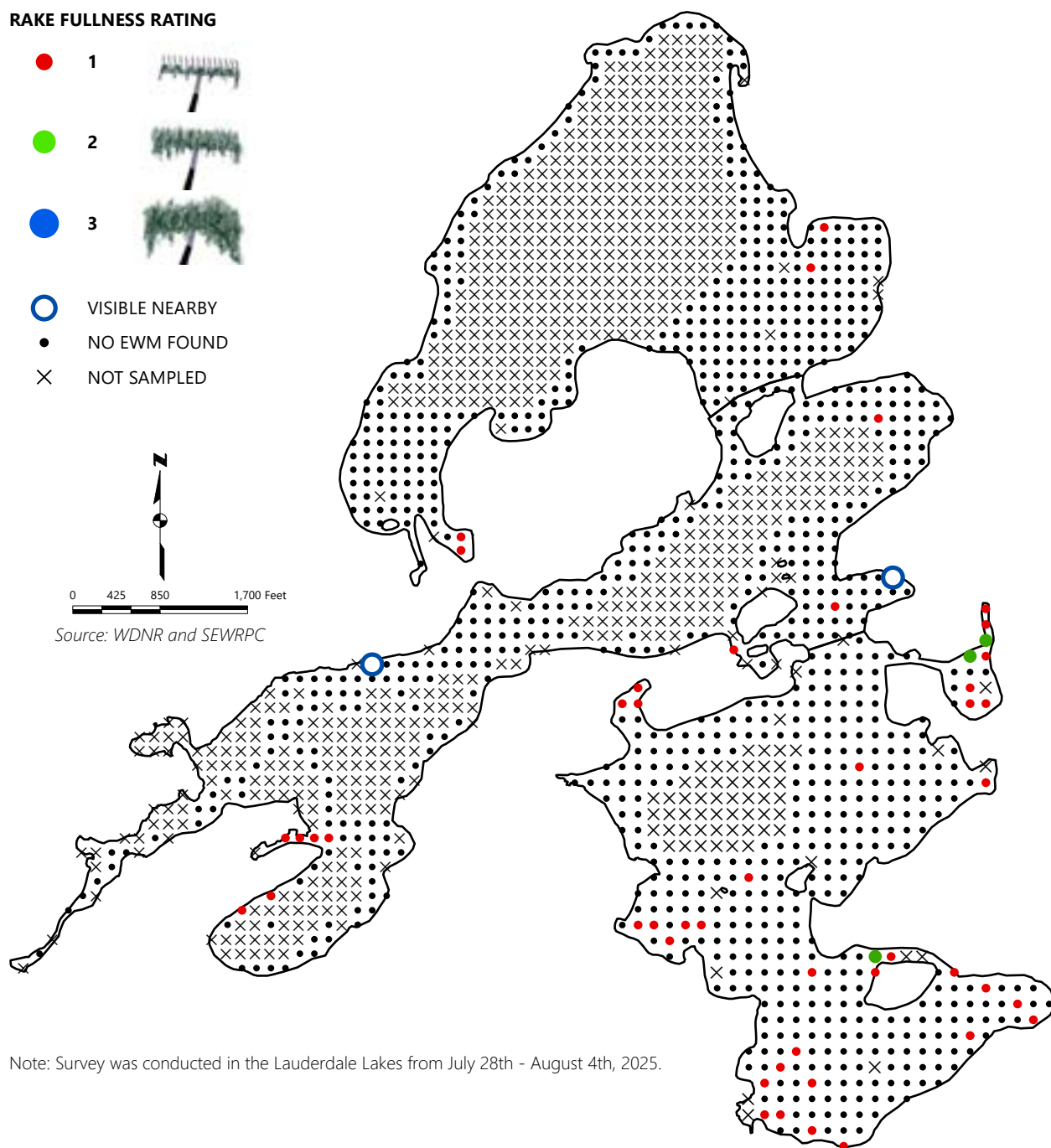
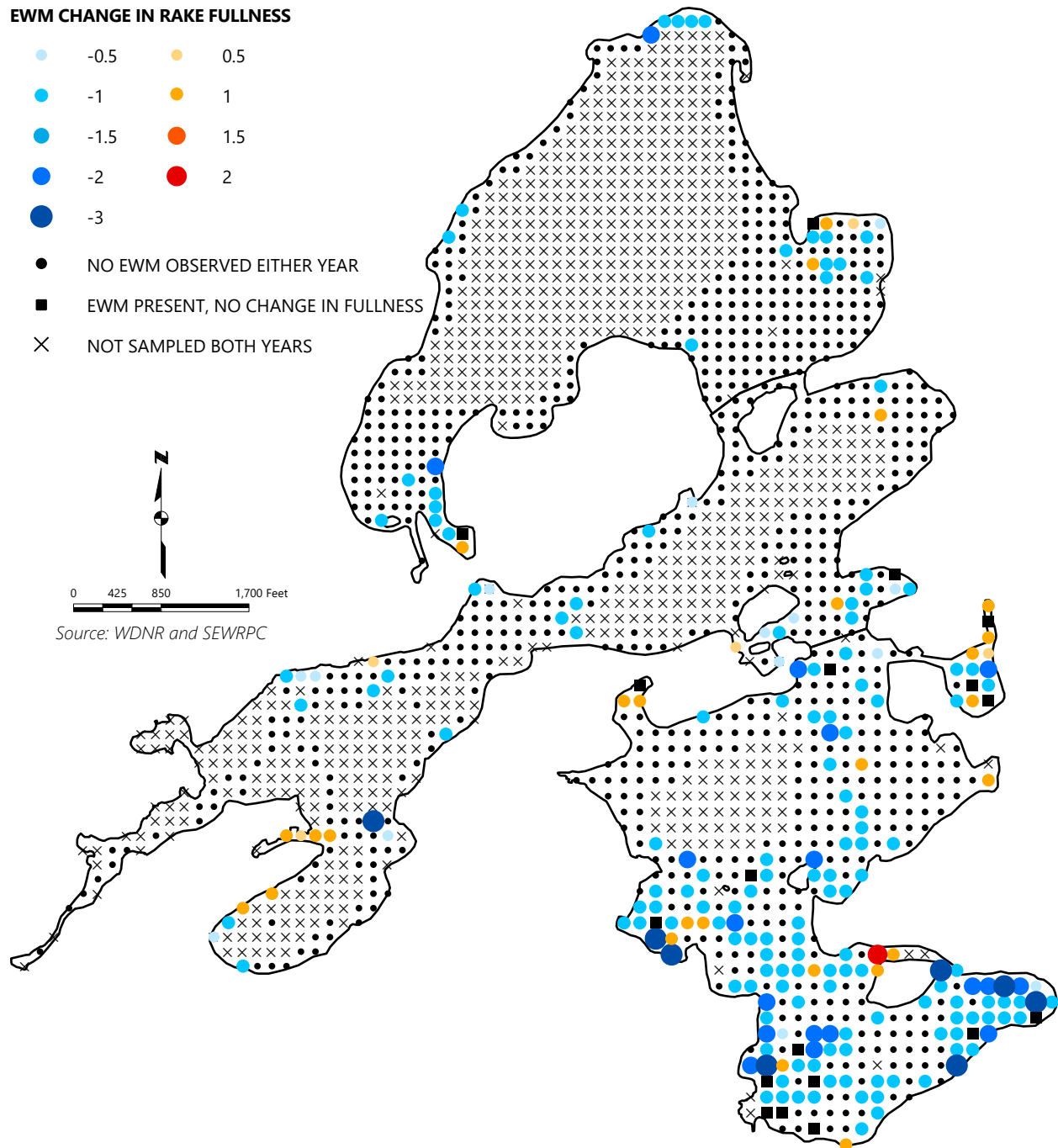


Figure 2.13
Change in Eurasian Watermilfoil Rake Fullness in the Lauderdale Lakes: 2019-2025



Apparent Changes in Green Lake's Observed Aquatic Plant Communities: 2019 Versus 2025

The 2025 aquatic plant survey identified a total of 22 different plant species including visual observations in Green Lake, similar to the 19 species found in the 2019 aquatic plant survey. Overall, the plant species found in the Lake remain largely the same.

In addition to the number of different aquatic plant species detected in the Lake, several other comparisons can be drawn between the 2019 and 2025 aquatic plant survey results, as examined below:

- The total littoral vegetated frequency of occurrence increased by 22.5 percent from 2019 to 2025. It was 84.4 percent in 2025 compared to 61.9 percent in 2019 (see Table 2.5). Aquatic vegetation particularly increased in the southeastern corner of Green Lake compared to 2019, when mostly barren sand was observed. These changes may be due to enhanced water clarity and higher MDC.
- The MDC in Green Lake during the 2025 survey was 18 feet, 4.5 feet deeper than the 2019 survey, where the MDC was 13.5 feet (see Table 2.5).
- The composition and order of the five most common species changed from 2019 to 2025. Four of the five top-most common species remained the same but one of the other most common species changed. In 2025 the five were 1) muskgrass, 2) sago pondweed, 3) spiny naiad, 4) eelgrass, and 5) slender naiad. In 2019 the five most common species were 1) muskgrass, 2) eelgrass, 3) sago pondweed, 4) arum-leaved arrowhead (*Sagittaria cuneata*), and 5) spiny naiad.
- Several native aquatic plant species have small populations within Green Lake including common waterweed (*Elodea canadensis*), water stargrass (*Heteranthera dubia*), spatterdock (*Nuphar variegata*), white waterlily (*Nymphaea odorata*), white water crowfoot (*Ranunculus aquatilis*), and several pondweeds (*P. friesii*, *P. illinoensis*, *P. natans*, *P. illinoensis X natans*, and *P. zosteriformis*), all of which were found at less than five points across the Lake (see Table 2.7).
- Overall, the sensitive species richness decreased between 2019 and 2025 by one species.⁵⁰ Three sensitive aquatic plants, slender naiad (*Najas flexilis*), variable pondweed (*Potamogeton gramineus*), and small bladderwort (*Utricularia minor*), were found during the 2019 survey. Two sensitive species, slender naiad (*Najas flexilis*) and variable pondweed (*Potamogeton gramineus*), found in the 2025 survey. Gains and losses in the number of sensitive species at each survey point were distributed throughout Green Lake, with 21 points gaining sensitive species, and 19 sites losing them (see Table 2.7 and Figure 2.14).
- EWM occurrence decreased greatly between 2019 and 2025. It was found at 24 points in 2019 and four sites in 2025, with an additional two visual sightings in both 2019 and 2025, respectively (see Table 2.7 and Figure 2.13).
- CLP occurrence increased only through visual sighting, as it was found at zero points in both 2019 and 2025. There were no visual sightings in 2019 and only one sighting in 2025 (see Table 2.7 and Figure 2.9).
- Spiny naiad occurrence increased greatly from 2019 where it was found at 30 points. It was found at 87 points in 2025, with no visual sightings either year (see Table 2.7 and Figure 2.11).
- Starry stonewort was first observed in Green Lake in 2025 and was found at 11 sites with no visual sightings (see Table 2.7 and Figure 2.7).

Apparent Changes in Middle Lake's Observed Aquatic Plant Communities: 2019 Versus 2025

The 2025 aquatic plant survey identified a total of 32 different plant species including visual observations, slightly more than the 26 species found in the 2019 aquatic plant survey. Overall, the plant species found in the Lake remain largely the same.

⁵⁰ As defined by the Mikulyuk et al. study.

Table 2.7
Aquatic Plant Abundance in Green Lake: Summer 2019 Versus Summer 2025

Aquatic Plant Species	Native or Invasive	Number of Sites Found^a (2019/2025)	Frequency of Occurrence Within Vegetated Areas^b (2019/2025)	Average Rate of Fullness^c (2019/2025)	Relative Frequency of Occurrence^d (2019/2025)	Visual Sightings^e (2019/2025)
<i>Ceratophyllum demersum</i> (Coontail)	Native	1/1	0.6/0.33	1.0/1.0	0.3/0.2	0/0
<i>Chara</i> sp. (Muskgrasses)	Native	102/211	60.7/70.10	1.4/1.59	29.5/36.8	11/7
<i>Elodea canadensis</i> (Common waterweed)	Native	3/2	1.8/0.66	1.0/1.0	0.9/0.3	0/0
<i>Heteranthera dubia</i> (Water stargrass)	Native	1/1	0.6/0.33	1.0/1.0	0.3/0.2	0/0
<i>Myriophyllum spicatum</i> (Eurasian water milfoil)	Invasive	24/4	14.3/1.33	1.1/1.0	6.9/0.7	2/2
<i>Najas flexilis</i> (Slender naiad)	Native	15/25	8.9/8.31	1.1/1.28	4.3/4.4	0/1
<i>Najas marina</i> (Spiny naiad) ^f	Naturalized	30/87	17.9/28.90	1.0/1.20	8.7/15.2	0/0
<i>Nuphar variegata</i> (Spatterdock)	Native	0/0	0/0	0/0	0/0	3/3
<i>Nitellopsis obtusa</i> (Starry stonewort)	Invasive	0/11	0/3.65	0/1.18	0/0.9	0/0
<i>Nymphaea odorata</i> (White water lily)	Native	0/0	0/0	0/0	0/0	5/7
<i>Potamogeton crispus</i> (Curly-leaf pondweed)	Invasive	0/0	0/0	0/0	0/0	0/1
<i>Potamogeton friesii</i> (Fries' pondweed)	Native	1/4	0.6/1.33	1.0/1.0	0.3/0.7	0/0
<i>Potamogeton gramineus</i> (Variable pondweed)	Native	7/5	4.2/1.66	1.1/1.2	2.0/0.9	5/7
<i>Potamogeton illinoensis</i> (Illinois pondweed)	Native	0/1	0/0	0/0	0/0.2	0/0
<i>Potamogeton illinoensis</i> X <i>natans</i> (Hybrid Illinois and floating pondweed)	Native	0/2	0/0.66	0/1.0	0/0.3	0/3
<i>Potamogeton natans</i> (Floating-leaf pondweed)	Native	0/0	0/0	0/1.0	0/0	1/1
<i>Potamogeton praelongus</i> (White-stem pondweed)	Native	5/0	3.0/0	1.0/1.0	1.4/0	1/0
<i>Potamogeton zosteriformis</i> (Flat-stem pondweed)	Native	2/3	1.2/1.0	1.0/1.0	0.6/0.5	0/1
<i>Ranunculus aquatilis</i> (White-water crowfoot)	Native	0/1	0/0.33	0/1.0	0/0.2	0/0
<i>Sagittaria cuneata</i> (Arrow-leaved arrowhead)	Native	30/19	17.9/6.31	1.2/1.11	8.7/3.3	4/3
<i>Stuckenia pectinata</i> (Sago pondweed)	Native	53/95	31.6/31.56	1.1/1.19	15.3/16.6	2/11
<i>Utricularia minor</i> (Small bladderwort)	Native	1/0	0.6/0	1.0/0	0.3/0	0/0
<i>Utricularia vulgaris</i> (Common bladderwort)	Native	8/22	4.8/7.31	1.0/1.09	2.3/3.8	0/0
<i>Vallisneria spiralis</i> (Wild celery)	Native	63/79	37.5/26.25	1.0/1.01	18.2/13.8	2/8

Table continued on next page.

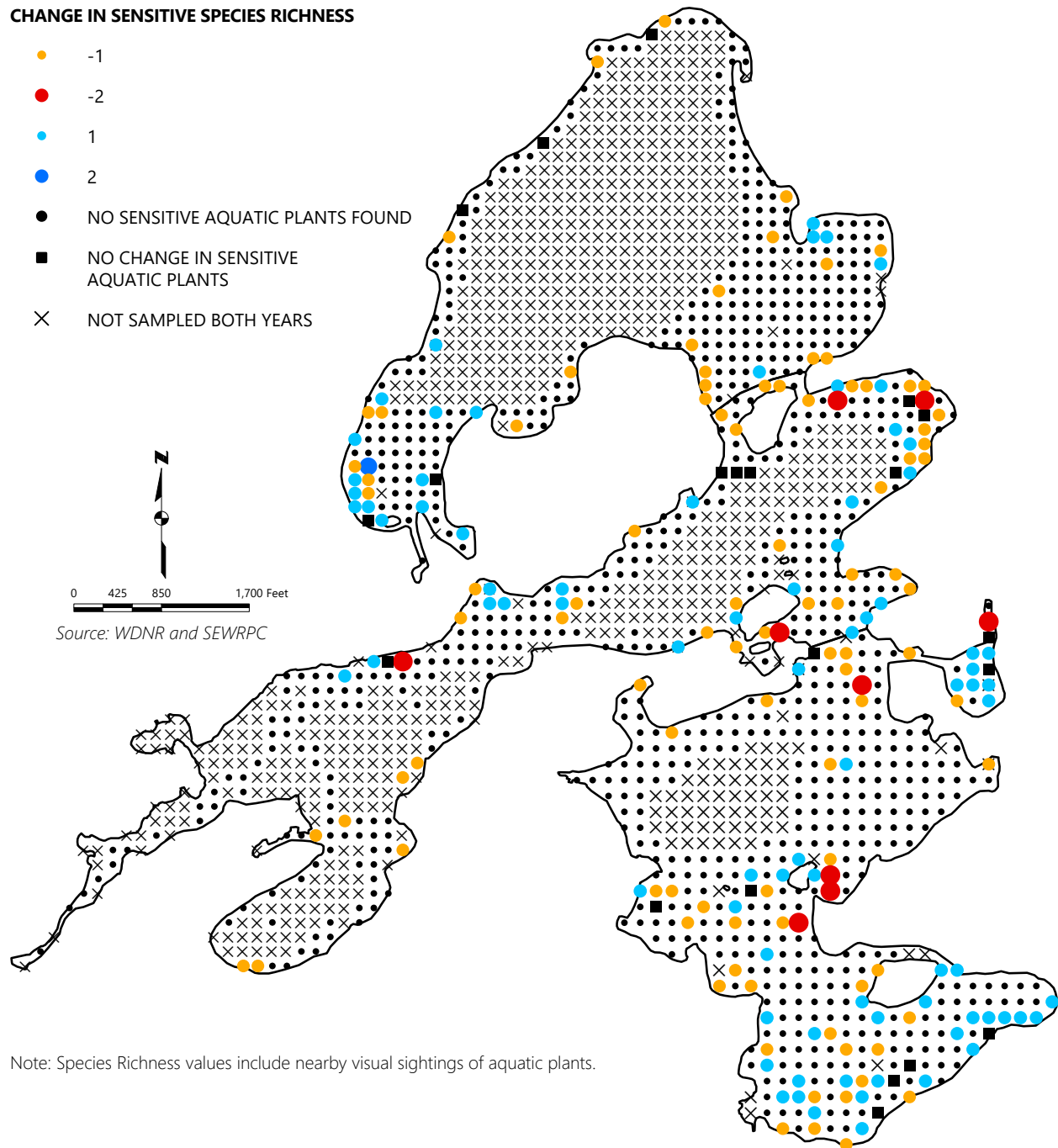
Table 2.7 (Continued)

Note: Red text indicates non-native and/or invasive species. See Appendix A for common aquatic plant distribution maps.

- ^a Number of Sites refers to the number of sites at which the species was retrieved and identified on the rake during sampling.
- ^b Frequency of Occurrence, expressed as a percent, is the percentage of times a particular species occurred when there was aquatic vegetation present at the sampling site.
- ^c Average rake fullness is the average amount, on a scale of 0 to 3, of a particular species at each site where that species was retrieved by the rake.
- ^d Relative Frequency of Occurrence, expressed as a percent, is the frequency of that particular species compared to the frequencies of all species present.
- ^e Visual Sightings is the number of sites where that particular species was visually observed within six feet of the actual rake haul location but was not actually retrieved on the rake and was not, therefore, assigned a rake fullness measurement for that site. At sites where this occurred, the species was simply marked as "present" at that site. Recording the number of visual sightings helps give a better picture of species distribution throughout the lake.
- ^f Spiny naiad was added to the NR 40 list as a restricted species in 2015, meaning it is not allowed to be transported, transferred, or introduced without a permit. Because the species is not native to Wisconsin and can become quite abundant, especially in lakes of poor water quality with hard water, it is currently considered a "naturalized" native species that can provide good habitat and food for fish and macroinvertebrates. Paul M. Skawinski, Aquatic Plants of the Upper Midwest, 2nd Edition, 2014; Through the Looking Glass: A Field Guide to Aquatic Plants, 2nd Edition, 2013.

Source: WDNR and SEWRPC

Figure 2.14
Change in Sensitive Species Richness in the Lauderdale Lakes: 2019-2025



In addition to the number of different aquatic plant species detected in the Lake, several other comparisons can be drawn between the 2019 and 2025 aquatic plant survey results, as examined below:

- The total littoral vegetated frequency of occurrence decreased by 1 percent from 2019 to 2025. It was 75.4 percent in 2025 compared to 76.2 percent in 2019 (see Table 2.5).
- The MDC in Middle Lake during the 2025 survey was 12 feet, one foot shallower than the 2019 survey, where the MDC was 13 feet (see Table 2.5).
- The composition and order of the five most common species changed from 2019 to 2025. Four of the five top-most common species remained the same but one of the other most common species changed. In 2025 the five were 1) muskgrass, 2) eelgrass, 3) sago pondweed, 4) spiny naiad, and 5) common bladderwort. In 2019 the five most common species were 1) muskgrass, 2) spiny naiad, 3) eelgrass, 4) arrowhead (*Sagittaria cuneata*), and 5) Sago pondweed.
- Several native aquatic plant species have small populations within Middle Lake including coontail (*Ceratophyllum demersum*), common waterweed (*Elodea canadensis*), water stargrass (*Heteranthera dubia*), northern watermilfoil (*Myriophyllum sibiricum*), southern naiad (*Najas guadalupensis*), nitella species (*Nitella* spp.), white water crowfoot (*Ranunculus aquatilis*), small bladderwort (*Utricularia minor*), wild rice (*Zizania aquatica*), and several pondweeds (*P. friesii*, *illinoensis*, and *natans*), all of which were found at less than five points across the Lake (see Table 2.8).
- Overall, the sensitive species richness increased between 2019 and 2025 by two species. Middle Lake was found to have six sensitive species in the 2025 survey: slender naiad (*Najas flexilis*), Southern naiad (*Najas guadalupensis*), nitella (*Nitella* sp.), variable pondweed (*Potamogeton gramineus*), creeping bladderwort (*Utricularia gibba*), and small bladderwort (*Utricularia minor*). The 2019 survey observed four sensitive species: slender naiad (*Najas flexilis*), small nitella (*Nitella tenuissima*), variable pondweed (*Potamogeton gramineus*), and small bladderwort (*Utricularia minor*) were found during the 2019 survey. Gains and losses in the number of sensitive species at each survey point were distributed throughout Middle Lake, with 20 points gaining sensitive species, and 41 sites losing them (see Table 2.8 and Figure 2.14).
- EWM occurrence decreased greatly between 2019 and 2025. It was found at 20 points in 2019 and nine sites in 2025 with an additional 13 visual sightings in 2019 and two visual sightings in 2025, (see Table 2.8 and Figure 2.13).
- CLP occurrence was similar, as it was found at two points in 2019 and one point in 2025. There were no visual sightings in 2019 and only one sighting in 2025 (see Table 2.8 and Figure 2.9).
- Spiny naiad occurrence decreased greatly from 2019 where it was found at 56 points and seen as a visual observation at 5 points. In 2025, it was found at 29 points, with 9 visual sightings (see Table 2.8 and Figure 2.10).
- Starry stonewort was first observed in Middle Lake in 2025 and was found at 6 points with no visual sightings (see Table 2.8 and Figure 2.7).

Apparent Changes in Mill Lake's Observed Aquatic Plant Communities: 2019 Versus 2025

The 2025 aquatic plant survey identified a total of 25 different plant species including visual observations in Mill Lake, slightly more than the 22 species found in the 2019 aquatic plant survey. In addition to the number of different aquatic plant species detected in the Lake, several other comparisons can be drawn between the 2019 and 2025 aquatic plant survey results, as examined below:

- The total littoral vegetated frequency of occurrence decreased by 2 percent from 2019 to 2025. It was 77.6 percent in 2025 compared to 79.4 percent in 2019 (see Table 2.5).
- The MDC in Mill Lake during the 2025 survey was 13 feet, a half-foot shallower than the 2019 survey, where the MDC was 13.5 feet (see Table 2.5).

Table 2.8
Aquatic Plant Abundance in Middle Lake: Summer 2019 Versus Summer 2025

Aquatic Plant Species	Native or Invasive	Number of Points Found^a (2019/2025)	Frequency of Occurrence Within Vegetated Areas^b (2019/2025)	Average Rate Fullness^c (2019/2025)	Relative Frequency of Occurrence^d (2019/2025)	Visual Sightings^e (2019/2025)
<i>Ceratophyllum demersum</i> (Coontail)	Native	3/2	1.4/0.92	1.0/1.0	0.7/0.5	0/0
<i>Chara</i> sp. (Muskgrasses)	Native	157/185	72.0/85.25	1.7/1.71	36.9/44.6	10/14
<i>Elodea canadensis</i> (Common waterweed)	Native	2/4	0.9/1.84	1.5/1.0	0.5/1.0	2/0
<i>Heteranthera dubia</i> (Water stargrass)	Native	0/1	0/0.46	0/1.0	0/0.2	0/0
<i>Lemna minor</i> (Small duckweed)	Native	0/1	0/0.46	0/1.0	0/0.2	0/6
<i>Myriophyllum sibiricum</i> (Northern watermilfoil)	Native	0/2	0/0.92	0/1.0	0/0.5	0/0
<i>Myriophyllum spicatum</i> (Eurasian watermilfoil)	Invasive	20/9	9.2/4.15	1.1/1.0	4.7/2.2	13/2
<i>Myriophyllum verticillatum</i> (Whorled watermilfoil)	Native	11/0	5.0/0	1.5/0	2.6/0	21/0
<i>Najas flexilis</i> (Slender naiad)	Native	22/27	10.1/12.44	1.1/1.07	5.2/6.5	2/2
<i>Najas guadalupensis</i> (Southern naiad)	Native	0/1	0/0.46	0/1.0	0/0.2	1/0
<i>Najas marina</i> (Spiny naiad) ^f	Naturalized	56/29	25.7/13.36	1.3/1.21	13.1/7.0	5/9
<i>Nitella tenuissima</i> (Small nitella)	Native	1/0	0.5/0	1.0/0	0.2/0	0/0
<i>Nitella</i> sp. (Nitella)	Native	0/2	0/0.92	0/1.0	0/0.5	0/0
<i>Nitellopsis obtusa</i> (Starry stonewort)	Invasive	0/6	0/2.76	0/1.17	0/1.4	0/0
<i>Nuphar variegata</i> (Spatterdock)	Native	6/5	2.8/2.30	1.2/1.2	1.4/1.2	22/47
<i>Potamogeton crispus</i> (Curly-leaf pondweed)	Invasive	2/1	0.9/0.46	1.5/1.0	0.5/0.2	0/1
<i>Potamogeton friesii</i> (Fries' pondweed)	Native	1/1	0.5/0.46	1.0/1.0	0.2/0.2	0/1
<i>Potamogeton gramineus</i> (Variable pondweed)	Native	9/6	4.1/2.76	1.0/1.0	2.1/1.4	9/9
<i>Potamogeton illinoensis</i> (Illinois pondweed)	Native	0/1	0/0.46	0/1.0	0/0.2	0/0
<i>Potamogeton natans</i> (Floating-leaf pondweed)	Native	2/2	0.9/0.92	1.0/1.0	0.5/0.5	4/6
<i>Potamogeton zosteriformis</i> (Flat-stem pondweed)	Native	0/0	0/0	0/0	0/0	3/0
<i>Ranunculus aquatilis</i> (White water crowfoot)	Native	0/1	0/0.46	0/1.0	0/0.2	1/0
<i>Sagittaria cuneata</i> (Arum-leaved arrowhead)	Native	35/22	16.1/10.14	1.2/1.18	8.2/5.3	19/26
<i>Schoenoplectus acutus</i> (Hardstem bulrush)	Native	0/1	0/0.46	0/1.0	0/0.2	14/8
<i>Sparganium emersum</i> (Short-stemmed bur-reed)	Native	0/0	0/0	0/0	0/0	1/0
<i>Sparganium natans</i> (Small bur-reed)	Native	6/0	2.8/0	1.2/0	1.4/0	3/1
<i>Sparganium</i> sp. (Bur-reed)	Native	0/3	0/1.38	0/1.33	0/0.7	0/1
<i>Spirodela polyrrhiza</i> (Large duckweed)	Native	0/1	0/0.46	0/1.0	0/0.2	0/3
<i>Stuckenia pectinata</i> (Sago pondweed)	Native	33/33	15.1/15.21	1.0/1.09	7.7/8.0	8/15
<i>Typha</i> sp. (Cattail)	Native	0/0	0/0	0/0	0/0	0/1
<i>Utricularia gibba</i> (Creeping bladderwort)	Native	0/0	0/0	0/0	0/0	0/2

Table continued on next page.

Table 2.8 (Continued)

Aquatic Plant Species	Native or Invasive	Number of Points Found^a (2019/2025)	Frequency of Occurrence Within Vegetated Areas^b (2019/2025)	Average Rake Fullness^c (2019/2025)	Relative Frequency of Occurrence^d (2019/2025)	Visual Sightings^e (2019/2025)
<i>Utricularia minor</i> (Small bladderwort)	Native	0/1	0/0.46	0/1.0	0/0.2	0/0
<i>Utricularia vulgaris</i> (Common bladderwort)	Native	15/28	6.9/12.9	1.0/1.11	3.5/6.7	3/20
<i>Vallisneria spiralis</i> (Wild celery)	Native	43/36	19.7/16.59	1.1/1.17	10.1/8.7	5/12
<i>Zizania aquatica</i> (Southern wild rice)	Native	0/3	0/1.38	0/1.33	0/0.7	5/6

Note: Red text indicates non-native and/or invasive species.

^a Number of Sites refers to the number of sites at which the species was retrieved and identified on the rake during sampling.

^b Frequency of Occurrence, expressed as a percent, is the percentage of times a particular species occurred when there was aquatic vegetation present at the sampling site.

^c Average rake fullness is the average amount, on a scale of 0 to 3, of a particular species at each site where that species was retrieved by the rake.

^d Relative Frequency of Occurrence, expressed as a percent, is the frequency of that particular species compared to the frequencies of all species present.

^e Visual Sightings is the number of sites where that particular species was visually observed within six feet of the actual rake haul location but was not actually retrieved on the rake and was not, therefore, assigned a rake fullness measurement for that site. At sites where this occurred, the species was simply marked as "present" at that site. Recording the number of visual sightings helps give a better picture of species distribution throughout the lake.

^f Spiny naiad was added to the NR 40 list as a restricted species in 2015, meaning it is not allowed to be transported, transferred, or introduced without a permit. Because the species is not native to Wisconsin and can become quite abundant, especially in lakes of poor water quality with hard water, it is currently considered a "naturalized" native species that can provide good habitat and food for fish and macroinvertebrates. Paul M. Skawinski, Aquatic Plants of the Upper Midwest, 2nd Edition, 2014; Through the Looking Glass: A Field Guide to Aquatic Plants, 2nd Edition, 2013.

Source: WDNR and SEWRPC

- The composition and order of the five most common species slightly changed from 2019 to 2025, as the most abundant species in 2025 were, in decreasing order of abundance: 1) muskgrass, 2) eelgrass, 3) tie between common waterweed and spiny naiad, 4) common bladderwort and Eurasian watermilfoil (tie), and 5) Sago pondweed. In 2019 the five most common species were 1) muskgrass, 2) eelgrass, 3) Eurasian watermilfoil, 4) spiny naiad, and 5) sago pondweed.
- Several native aquatic plant species have small populations within Mill Lake including spatterdock (*Nuphar variegata*), white waterlily (*Nymphaea odorata*) floating-leaf pondweed (*Potamogeton natans*), and hybrid Illinois X floating-leaf pondweed (*Potamogeton illinoensis X natans*), all of which were found at less than five points across the Lake (see Table 2.9).
- The sensitive species richness was the same in both species type and number. Mill Lake was found to have four sensitive species in the 2025 survey: slender naiad (*Najas flexilis*), Southern naiad (*Najas guadalupensis*), large-leaf pondweed (*Potamogeton amplifolius*), and variable pondweed (*Potamogeton gramineus*). These same four species were found in the 2019 survey. Gains and losses in the number of sensitive species at each survey point were distributed throughout Mill Lake, with 41 points gaining sensitive species, and 40 sites losing them (see Table 2.9 and Figure 2.14).
- EWM occurrence decreased greatly between 2019 and 2025. It was found at 137 points in 2019 with four visual sightings and was found at 36 sites in 2025 with no visual observations, (see Table 2.9 and Figure 2.13).
- CLP occurrence was similar, though increased slightly as it was found at no points in 2019 and five points in 2025. There were three visual sightings in 2019 and no additional sightings in 2025 (see Table 2.9 and Figure 2.9).
- Spiny naiad occurrence decreased from 2019 where it was found at 54 points and seen as a visual observation at one point. In 2025, it was found at 50 points, with 5 visual sightings (see Table 2.9 and Figure 2.11).
- Starry stonewort was first observed in Mill Lake in 2025 and was found at 19 sites with no visual sightings (see Table 2.9 and Figure 2.7).

2.3 PAST AND PRESENT AQUATIC PLANT MANAGEMENT PRACTICES

Aquatic plants have been managed on the Lauderdale Lakes since the late 1950s when sodium arsenite was used to control aquatic plants in the Lakes (see Table 2.10). This, alongside copper sulfate and Endothall for algal control, was used as the main chemical control up into the 1960s. By the 1980s and into the 90s, Diquat and 2,4-D became the main chemical elements to control aquatic plants. At the same time, copper sulfate and Aquathol became the standard for algal growth control in the Lakes. The District has not utilized chemical applications for aquatic plant management since 2009, however, there have been applications by private property owners and associations around the Lakes.⁵¹

Since 1992, mechanical aquatic macrophyte harvesting has been the primary aquatic plant control method used on the Lakes. Approximately 66,802 cubic yards of aquatic plants have been removed from the Lakes since 2002 (see Table 2.11). However, the estimates of aquatic plant volumes harvested have varied throughout the years due to differences in data collection and unit conversions, such as assumed aquatic plant density. These differences may account for changes in harvested volumes reported for individual years since the previous APM plan. Lake-wide harvesting operations are overseen and carried out by the District.

In recent years, several private property owners have also recently utilized diver-assisted suction harvesting (DASH) for treatment near their properties.⁵² Some of these property owners have docks within

⁵¹ See WDNR chemical aquatic plant control permits SE-2025-65-22363 and SE-2022-65-12375 as examples of permitted chemical treatment near the Lauderdale Shores and Baywood Estates private launches, respectively.

⁵² See WDNR mechanical aquatic plant control permits SE-2025-65-24294M and SE-2023-65-17141M as examples of recently permitted DASH treatments in the Lakes.

Table 2.9

Aquatic Plant Abundance in Mill Lake: Summer 2019 Versus Summer 2025

Aquatic Plant Species	Native or Invasive	Number of Points Found ^a (2019/2025)	Frequency of Occurrence Within Vegetated Areas ^b (2019/2025)	Average Rake Fullness ^c (2019/2025)	Relative Frequency of Occurrence ^d (2019/2025)	Visual Sightings ^e (2019/2025)
<i>Ceratophyllum demersum</i> (Coontail)	Native	8/11	2.8/3.73	1.8/1.3	1.1/1.5	1/0
<i>Chara</i> sp. (Muskgrasses)	Native	196/236	67.8/80.00	1.7/2	27.0/32.1	0/5
<i>Elodea canadensis</i> (Common waterweed)	Native	8/50	2.8/17.0	1.0/1.1	1.1/6.8	0/0
<i>Heteranthera dubia</i> (Water stargrass)	Native	8/18	2.8/6.1	1.3/1.4	1.1/2.4	0/0
<i>Lemna minor</i> (Small duckweed)	Native	1/0	0.35/0	1.0/0	0.27/0	1/1
<i>Myriophyllum spicatum</i> (Eurasian watermilfoil)	Invasive	137/36	47.4/12.20	1.2/1.08	18.8/4.9	4/0
<i>Myriophyllum verticillatum</i> (Whorled watermilfoil)	Native	15/0	5.2/0	1.4/0	2.1/0	1/0
<i>Najas flexilis</i> (Slender naiad)	Native	20/24	6.9/8.1	1.1/1.0	2.8/3.3	1/1
<i>Najas guadalupensis</i> (Southern naiad)	Native	19/14	6.6/4.8	1.1/1.3	2.6/1.9	0/0
<i>Najas marina</i> (Spiny naiad) ^f	Naturalized	54/50	18.7/17	1.2/1.3	7.4/6.8	1/5
<i>Nitellopsis obtusa</i> (Starry stonewort)	Invasive	0/19	0/6.4	0/1.11	0/2.6	0/0
<i>Nuphar variegata</i> (Spatterdock)	Native	1/3	0.3/1.0	1.0/1.3	0.1/0.4	3/7
<i>Nymphaea odorata</i> (White water lily)	Native	2/4	0.7/1.4	2.0/2.3	0.3/0.5	8/12
<i>Potamogeton amplifolius</i> (Large-leaf pondweed) ^g	Native	0/0	0/0	0/0	0/0	1/1
<i>Potamogeton crispus</i> (Curly-leaf pondweed)	Invasive	0/5	0/1.69	0/1.0	0/0.7	3/0
<i>Potamogeton friesii</i> (Fries' pondweed)	Native	0/6	0/2.0	0/1.0	0/0.8	0/0
<i>Potamogeton gramineus</i> (Variable pondweed)	Native	12/12	4.2/4.1	1.0/1.2	1.7/1.6	2/2
<i>Potamogeton illinoensis</i> X <i>natans</i> (Hybrid Illinois X Floating-leaf pondweed)	Native	0/1	0/0.34	0/1	0/0.1	0/1
<i>Potamogeton natans</i> (Floating-leaf pondweed)	Native	0/1	0/0.3	0/1.0	0/0.1	6/9
<i>Potamogeton zosteriformis</i> (Flat-stem pondweed)	Native	5/11	1.7/3.7	1.0/1.0	0.7/1.5	1/1
<i>Sagittaria cuneata</i> (Arum-leaved arrowhead)	Native	4/16	1.4/5.4	1.3/1.3	0.6/2.2	3/9
<i>Schoenoplectus pungens</i> (Three-square bulrush)	Native	0/0	0/0	0/0	0/0	0/1
<i>Spirodela polyrrhiza</i> (Large duckweed)	Native	0/0	0/0	0/0	0/0	0/1
<i>Stuckenia pectinata</i> (Sago pondweed)	Native	47/34	16.3/11.5	1.1/1.1	6.5/4.6	2/12
<i>Utricularia vulgaris</i> (Common bladderwort)	Native	35/36	12.1/12.2	1.1/1.1	4.8/4.9	1/4
<i>Vallisneria spiralis</i> (Wild celery)	Native	151/149	52.2/50.5	1.2/1.3	20.8/20.2	5/14

Table continued on next page.

Table 2.9 (Continued)

Note: Red text indicates non-native and/or invasive species. See Appendix A for common aquatic plant distribution maps.

^a Number of Sites refers to the number of sites at which the species was retrieved and identified on the rake during sampling.

^b Frequency of Occurrence, expressed as a percent, is the percentage of times a particular species occurred when there was aquatic vegetation present at the sampling site.

^c Average rake fullness is the average amount, on a scale of 0 to 3, of a particular species at each site where that species was retrieved by the rake.

^d Relative Frequency of Occurrence, expressed as a percent, is the frequency of that particular species compared to the frequencies of all species present.

^e Visual Sightings is the number of sites where that particular species was visually observed within six feet of the actual rake haul location but was not actually retrieved on the rake and was not, therefore, assigned a rake fullness measurement for that site. At sites where this occurred, the species was simply marked as "present" at that site. Recording the number of visual sightings helps give a better picture of species distribution throughout the lake.

^f Spiny naiad was added to the NR 40 list as a restricted species in 2015, meaning it is not allowed to be transported, transferred, or introduced without a permit. Because the species is not native to Wisconsin and can become quite abundant, especially in lakes of poor water quality with hard water, it is currently considered a "naturalized" native species that can provide good habitat and food for fish and macroinvertebrates. Paul M. Skawinski, Aquatic Plants of the Upper Midwest, 2nd Edition, 2014; Through the Looking Glass: A Field Guide to Aquatic Plants, 2nd Edition, 2013.

Source: WDNR and SEWRPC

Table 2.10
Aquatic Plant Chemical Control Agents Applied to Lauderdale Lakes: 1959-2024

Year	Copper Sulfate		Cutrine or Cutrine Plus (gallons)	Sodium Arsenite (pounds)	2,4-D		2,4,5-TP (gallons)	2,4,5-T (gallons)	Diquat (gallons)	Endothal/Aquathol	
	Pounds	Gallons			Gallons	Pounds				Gallons	Pounds
1950-1969	15,181.0	--	--	20,566	80.0	--	92.6	52.0	78.0	9.0	48.4
1970	--	--	--	--	--	--	--	--	15.0	10.0	300
1971	--	--	--	--	--	--	--	--	--	67.0	--
1972	--	--	--	--	--	--	--	--	6.0	41.0	--
1973	--	--	--	--	--	--	--	--	18.0	8.0	--
1974	--	--	--	--	--	--	--	--	--	--	--
1975	--	--	--	--	4.0	--	--	--	--	8.0	--
1976	--	--	--	--	--	--	--	--	--	--	--
1977	--	--	--	--	--	--	--	--	--	22.0	--
1978	--	--	5.0	--	--	--	--	--	--	--	--
1979	--	--	5.0	--	--	--	--	--	--	--	--
1980	100.0	--	--	--	--	--	--	--	2.0	10.0	100
1981	8.0	--	--	--	48.0	--	--	--	4.0	9.0	50
1982	30.0	--	--	--	--	--	--	--	5.5	12.0	160
1983	--	--	--	--	--	--	--	--	4.0	28.0	--
1984	36.0	--	--	--	--	--	--	--	--	--	--
1985	--	--	--	--	13.5	--	--	--	1.0	10.0	--
1986	3.0	--	--	--	13.0	--	--	--	1.0	14.0	--
1987	0.5	--	--	--	41.0	--	--	--	1.5	--	61.7
1988	--	--	--	--	21.0	--	--	--	0.5	3.5	--
1989	--	--	--	--	22.0	--	--	--	--	1.5	--
1990	--	--	--	--	--	--	--	--	--	--	--
1991	--	--	--	--	14.0	--	--	--	--	--	--
1992	--	--	--	--	6.0	--	--	--	--	--	--
1993-2001	--	--	--	--	2.5	--	--	--	--	--	--
2002 ^a	--	2.7	--	--	--	--	--	--	--	--	--
2003	--	1.3	--	--	--	--	--	--	2.7	2.7	10.0
2004	--	--	--	--	--	--	--	--	1.3	1.0	--
2005	--	--	--	--	2.5	138	--	--	--	--	--
2006	--	--	--	--	--	--	--	--	0.8	1.0	--
2007	--	1.0	--	--	--	--	--	--	0.5	1.7	--
2008	--	2.0	--	--	--	--	--	--	1.5	2.5	--
2009-Present ^b	--	2.0	--	--	--	--	--	--	0.6	2.5	--
Total	15,358.5	9.0	--	20,566	267.5	138	92.6	52.0	143.9	264.4	730.1

Note: N/A indicates records are not available or no chemical applications were reported as made during this year.

^a In 2002, 0.7 gallons of Aquashade was applied.

^b Chemical treatments have been limited to private property applications since the inception of the harvesting program in the Lauderdale Lakes.

Source: WDNr and SEWRPC

WDNR-designated Sensitive Areas where chemical treatment is either prohibited or limited. Consequently, DASH provides a mechanical alternative for small-scale aquatic plant control that is generally permitted due to its low impacts on non-target species and areas.

A benefit of harvesting (including suction harvesting) versus chemical treatment is that harvesting physically removes plant mass and the nutrients contained therein. These nutrients, such as phosphorus, can contribute to Lake eutrophication; their removal can therefore decrease the amount of nutrient loading contributed by yearly surface runoff and tributary streams. The amount of phosphorus removed was unable to be confidently estimated by available records, though a more robust harvesting program means larger nutrient removal.

2.4 POTENTIAL AQUATIC PLANT CONTROL METHODOLOGIES

Aquatic plant management techniques can be classified into six categories.

- *Physical measures* include lake bottom coverings
- *Biological measures* include the use of organisms such as herbivorous insects
- *Manual measures* involve physically removing plants by hand or using hand-held tools such as rakes
- *Mechanical measures* rely on artificial power sources and remove aquatic plants with a machine known as a harvester or by suction harvesting
- *Chemical measures* use aquatic herbicides to kill nuisance and nonnative plants *in-situ*
- *Water level manipulation measures* utilize fluctuations in water levels to reduce aquatic plant abundance and promote growth of specific native species

All aquatic plant control measures are stringently regulated and most require a State of Wisconsin permit. Chemical controls, for example, require a permit and are regulated under *Wisconsin Administrative Code* Chapter NR 107, "Aquatic Plant Management" while placing bottom covers (a physical measure) requires a WDNR permit under Chapter 30 of the *Wisconsin Statutes*. All other aquatic plant management practices are regulated under *Wisconsin Administrative Code* Chapter NR 109, "Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations". Furthermore, the aquatic plant management measures described in this plan are consistent with the requirements of Chapter NR 7, "Recreational Boating Facilities Program", and with the public recreational boating access requirements relating to eligibility under the State cost-share grant programs set forth in *Wisconsin Administrative Code* Chapter NR 1, "Natural Resources Board Policies". More details about aquatic plant management are discussed in the following sections while recommendations are provided later in this document.

Non-compliance with aquatic plant management permit requirements is an enforceable violation of Wisconsin law and may lead to fines and/or complete permit revocation. The information and recommendations provided in this memorandum help frame permit requirements. Permits can cover up to a five-year period.⁵³

⁵³ Five-year permits allow a consistent aquatic plant management plan to be implemented over a significant length of time. This process allows the selected aquatic plant management measures to be evaluated at the end of the permit cycle.

Table 2.11
Volume of Aquatic Plants
Harvested in the Lauderdale
Lakes: 2002-2025

Year	Plant Material Removed (cubic yards)
2002	3,720
2003	2,322
2004	2,406
2005	2,082
2006	2,436
2007	2,172
2008	2,112
2009	2,454
2010	1,674
2011	--
2012	2,061
2013	2,313
2014	1,899
2015	2,094
2016	2,079
2017	2,187
2018	2,178
2019	3,024
2020	3,379
2021	4,032
2022	5,055
2023	6,035
2024	6,063
2025	6,049
Total	66,802
Average	3,036

Note: Information for 2011 was not available at time report was written.

Source: Lauderdale Lakes Lake Management District and WDNR

At the end of that period, the aquatic plant management plan must be updated. The updated plan must consider the results of a new aquatic plant survey and should evaluate the success, failure, and effects of earlier plant management activities that have occurred on the lake.⁵⁴ These plans and plan execution are reviewed and overseen by the WDNR regional lakes and aquatic invasive species coordinators.⁵⁵

Physical Measures

Lake-bottom covers and light screens provide limited control of rooted plants by creating a physical barrier that reduces or eliminates plant-available sunlight. Various materials such as pea gravel or synthetics like polyethylene, polypropylene, fiberglass, and nylon can be used as covers. The longevity, effectiveness, and overall value of some physical measures is questionable. The WDNR does not permit these kinds of controls. Consequently, lake-bottom covers are not a viable aquatic plant control strategy for the Lake.

Biological Measures

Biological control offers an alternative to direct human intervention to manage nuisance or exotic plants. Biological control techniques traditionally use herbivorous insects that feed upon nuisance plants. This approach has been effective in some southeastern Wisconsin lakes.⁵⁶ For example, milfoil weevils (*Eurhychiopsis lecontei*) have been used to control EWM. Milfoil weevils do best in waterbodies with balanced panfish populations,⁵⁷ where dense EWM beds reach the surface close to shore, where natural shoreline areas include leaf litter that provides habitat for over-wintering weevils, and where there is comparatively little boat traffic. This technique is not presently commercially available, making the use of milfoil weevils non-viable.

Manual Measures

Manually removing specific types of vegetation is a highly selective means of controlling nuisance aquatic plant growth, including invasive species such as EWM and SSW. Two commonly employed methods include hand raking and hand pulling. Both physically remove target plants from a lake. Since the vast majority of plant stems, leaves, roots, and seeds are actively removed from the lake, the reproductive potential and nutrients contained by pulled/raked plants material are also removed. These plants, seeds, and nutrients would otherwise re-enter the lake's water column or be deposited on the lake bottom. Hence, this aquatic plant management technique helps incrementally maintain water depth, improves water quality, and can help decrease the spread of nuisance/exotic plants. Hand raking and hand pulling are readily allowed by WDNR and are practical methods to control riparian landowner scale problems.

Raking with specially designed hand tools is particularly useful in shallow nearshore areas. This method allows nonnative plants to be removed and provides a safe and convenient aquatic plant control method in deeper nearshore waters around piers and docks. Advantages of this method include:

- Tools are inexpensive (\$100 to \$150 each)
- The method is easy to learn and use
- It may be employed by riparian landowners without a permit if certain conditions are met
- Results are immediately apparent
- Plant material is immediately removed from a lake (including seeds)⁵⁸

⁵⁴ *Aquatic plant harvesters must report harvesting activities as one of the permit requirements.*

⁵⁵ *Information on the current aquatic invasive species coordinator is found on the WDNR website.*

⁵⁶ B. Moorman, "A Battle with Purple Loosestrife: A Beginner's Experience with Biological Control," *LakeLine* 17(3): 20-21, 34-37, September 1997; see also, C.B. Huffacker, D.L. Dahlsen, D.H. Janzen, and G.G. Kennedy, "Insect Influences in the Regulation of Plant Population and Communities," 659-696, 1984; and C.B. Huffacker and R.L. Rabb, editors, *Ecological Entomology*, John Wiley, New York, New York, USA.

⁵⁷ *Panfish such as bluegill and pumpkinseed are predators of herbivorous insects. High populations of panfish lead to excess predation of milfoil weevils.*

⁵⁸ *Most of the material is removed during raking, however fragmentation/local spread from raking can occur in addition to fragmentation/local spread from wave action/other mechanical disruption.*

The second manual control method, hand-pulling whole plants (stems, roots, leaves, seeds) where they occur in isolated stands, is a simple means to control nuisance and invasive plants in shallow nearshore areas that may not support large-scale initiatives. This method is particularly helpful when attempting to target nonnative plants (e.g., EWM, curly-leaf pondweed) during the high growth season when native and nonnative species often mix. Hand pulling is more selective than raking, mechanical removal, and chemical treatments, and, if carefully applied, is less damaging to native plant communities. Recommendations regarding hand-pulling, hand-cutting, and raking are discussed later in this document.

Mechanical Measures

Two methods of mechanical harvesting are currently employed in Wisconsin - mechanical harvesting and suction harvesting. Both are regulated by WDNR and require a permit.⁵⁹

Mechanical Harvesting

Aquatic plants can be mechanically gathered using specialized equipment commonly referred to as harvesters. Harvesters use an adjustable depth cutting apparatus that can cut and remove plants from the water surface up to about five feet below the water surface. The harvester gathers cut plants with a conveyor, basket, or other device. Mechanical harvesting is often a very practical and efficient means to control nuisance plant growth and is widely employed in southeastern Wisconsin.

In addition to controlling plant growth, gathering and removing plant material from a lake reduces in-lake nutrient recycling, sedimentation, and targets plant reproductive potential. In other words, harvesting removes plant biomass, which would otherwise decompose and release nutrients, sediment, and seeds or other reproductive structures (e.g., turions, bulbils, plant fragments) into a lake. Mechanical harvesting is particularly effective and popular for large-scale open-water projects. However, small harvesters are also produced that are particularly suited to working around obstacles such as piers and docks in shallow nearshore areas. The navigation capabilities of these small harvesters could address nuisance plant growth near private piers that are currently treated using chemical applications.

An advantage of mechanical harvesting is that the harvester, when properly operated, “mows” aquatic plants and, therefore, typically leaves enough living plant material in place to provide shelter for aquatic wildlife and stabilize lake-bottom sediment. Harvesting, when done properly, does not kill aquatic plants, it simply trims plants back. Aside from residual plant mass remaining because of imperfect treatment strategy execution, none of the other aquatic plant management methods purposely leave living plant material in place after treatment. Aquatic plant harvesting has been shown to allow light to penetrate to the lakebed and stimulate regrowth of suppressed native plants. This is particularly effective when controlling invasive plant species that commonly grow quickly early in the season (e.g., EWM, curly-leaf pondweed) when native plants have not yet emerged or appreciably grown.

A disadvantage of mechanical harvesting is that the harvesting process may fragment plants and thereby unintentionally propagate EWM and curly-leaf pondweed. EWM fragments are particularly successful in establishing themselves in areas where plant roots have been removed. This underscores the need to avoid harvesting or otherwise disrupting native plant roots. Harvesting may also agitate bottom sediments in shallow areas, thereby increasing turbidity and resulting in deleterious effects such as smothering fish breeding habitat and nesting sites. To this end, most WDNR-issued permits do not allow deep-cut harvesting in water less than three feet deep, which limits the utility of this alternative in many littoral and shoal areas.⁶⁰ Nevertheless, if employed correctly and carefully under suitable conditions, harvesting can benefit navigation lane maintenance and can reduce regrowth of nuisance plants while maintaining, or even enhancing, native plant communities. The District has increased harvesting efforts in the Lakes in recent years and can be seen by the reported volume of aquatic plant material harvested over time (see Table 2.11). Since the last aquatic plant survey in 2019, the EWM population in the Lakes has decreased, which may in part be due to targeted physical removal of EWM.

⁵⁹ *Mechanical control permit conditions depend upon harvesting equipment type and specific equipment specifications.*

⁶⁰ *Deep-cut harvesting is harvesting to within one foot of the lake bottom. This is not allowed in shallow water because it is challenging to ensure that the harvester avoids lake-bottom contact in such areas.*

Cut plant fragments commonly escape the harvester's collection system and form mats or accumulate on shorelines. In addition, boating activity can fragment aquatic plants and also contribute to accumulations of cut plant fragments in the lake or along the shoreline. To compensate for this, most harvesting programs include a plant pickup program. Some plant pickup programs utilize a regularly scheduled aquatic plant pick up from lakefront property owner docks. Property owners are encouraged to actively rake plant debris along their shorelines and place these piles on their docks for collection. Due to navigation and safety concerns, harvesting barges cannot navigate directly up to the piers and thus a separate transport barge or boat may be used as a plant collection vessel. Specifications of plant pickup programs vary by Lake, though programs commonly employ harvesting crews to conduct these pickups weekly. This kind of program, when applied systematically, can reduce plant propagation from plant fragments and can help alleviate the negative aesthetic consequences of plant debris accumulating on shorelines. Additionally, property owners may also allow their collected plant debris to dry, then transport it to an approved dumping location.⁶¹ Approved dumping locations can be the municipality's refuse center, or collection dumpsters owned by the District and placed in common areas to later be disposed of by harvesting crews. Nevertheless, it is important to remember that normal boating activity (particularly during summer weekends) often creates far more plant fragments than generated from mechanical harvesting. Therefore, a plant pickup program is often essential to protect a lake's health and aesthetics, even in areas where harvesting has not recently occurred.

Suction Harvesting, DASH, and Diver-Assisted Hand Pulling

Another mechanical plant harvesting method uses suction to remove aquatic plants from a lake. Suction harvesting removes sediment, aquatic plants, plant roots, and anything else from the lake bottom and disposes of this material outside the lake. Since bottom material is removed from the lake, this technique also requires a dredging permit in addition to the aquatic plant management permit.

First permitted in 2014, DASH is a mechanical process where divers identify and pull select aquatic plants and roots from the lakebed and then insert the entire plant into a suction hose that transports the plant to the surface for collection and disposal. The process is a mechanically assisted method for hand-pulling aquatic plants. DASH was first utilized by Lauderdale Lakes riparian property owners in 2016 and continues to be utilized by nearshore residences.⁶²

Such labor-intensive work by skilled professional divers is, at present, a costly undertaking and long-term monitoring will need to evaluate the efficacy of the technique. If the District or individual property owners choose to employ DASH, a NR 109 permit is required. Nevertheless, many apparent advantages are associated with this method including: 1) lower potential to release plant fragments when compared to mechanical harvesting, raking, and hand-pulling, thereby reducing spread and growth of invasive plants like the newly found SSW; 2) increased selectivity of plant removal when compared to mechanical harvesting which in turn reduces native plant loss; and 3) lower potential for disturbing fish habitat.

Chemical Measures

Aquatic chemical herbicide use is stringently regulated. A WDNR permit and direct WDNR staff oversight is required during application. Chemical herbicide treatment is used for short time periods to temporarily control excessive nuisance aquatic plant growth. Chemicals are applied to growing plants in either liquid or granular form. Advantages of chemical herbicides aquatic plant growth control include low cost as well as the ease, speed, and convenience of application. However, many drawbacks are also associated with chemical herbicide aquatic plant control including the following examples.

- **Unknown and/or conflicting evidence about the effects of long-term chemical exposure on fish, fish food sources, and humans.** The U.S. Environmental Protection Agency, the agency responsible for approving aquatic plant treatment chemicals, studies aquatic plant herbicides to evaluate short-term exposure (acute) effects on human and wildlife health. Some studies also examine long-term (chronic) effects of chemical exposure on animals (e.g., the effects of being exposed to these herbicides for many years). However, it is often impossible to conclusively state that no long-term effects exist due to the animal testing protocol, time constraints, and other

⁶¹ *The Town of LaGrange operates a compost site through the growing season that can be used as a disposal location for aquatic plant material.*

⁶² www.lauderdalelakedistrict.com/documents/2017-february-170306103502.pdf.

factors. Furthermore, long-term studies cannot address all potentially affected species.⁶³ For example, conflicting studies/opinions exist regarding the role of the chemical 2,4-D as a human carcinogen.⁶⁴ Some lake property owners judge the risk of using chemicals as being excessive despite legality of use. Consequently, the concerns of lakefront owners should be considered whenever chemical treatments are proposed. Moreover, if chemicals are used, they should be applied as early in the season as practical. This helps assure that the applied chemical decomposes before swimming, water skiing, and other active body-contact lake uses begin.⁶⁵ Early season application also is generally the best time to treat EWM and curly-leaf pondweed for a variety of technical reasons explained in more detail as part of the “loss of native aquatic plants and related reduction or loss of desirable aquatic organisms” bullet below.

- **Reduced water clarity and increased risk of algal blooms.** Water-borne nutrients promote growth of both aquatic plants and algae. If rooted aquatic plant populations are depressed, demand for dissolved nutrients will be lessened. In such cases, algae tend to become more abundant, a situation reducing water clarity. For this reason, lake managers must avoid needlessly eradicating native plants and excessive chemical use. Lake managers must strive to maintain balance between rooted aquatic plants and algae - when the population of one declines, the other may increase in abundance to nuisance levels. In addition to upsetting the nutrient balance between rooted aquatic plants and algae, dead chemically treated aquatic plants decompose and contribute nutrients to lake water, a condition that may exacerbate water clarity concerns and algal blooms. The Lakes’ nutrient levels do not suggest they are regularly subject to algal blooms.⁶⁶
- **Reduced dissolved oxygen/oxygen depletion.** When chemicals are used to control large mats of aquatic plants, the dead plant material settles to the bottom of a lake and decomposes. Plant decomposition uses oxygen dissolved in lake water, the same oxygen that supports fish and many other vital beneficial lake functions. In severe cases, decomposition processes can deplete oxygen concentrations to a point where desirable biological conditions are no longer supported.⁶⁷ Ice covered lakes, and the deep portions of stratified lakes, are particularly vulnerable to oxygen depletion. Excessive oxygen loss can inhibit a lake’s ability to support certain fish and can trigger processes that release phosphorus from bottom sediment, further enriching lake nutrient levels. These concerns emphasize the need to limit chemical control and apply chemicals in *early* spring, when EWM and curly-leaf pondweed have not yet formed dense mats.
- **Increased organic sediment deposition.** Dead aquatic plants settle to a lake’s bottom, and, because of limited oxygen and/or rapid accumulation, may not fully decompose. Accumulation of this material can create flocculent organic-rich sediment and ultimately reduce water depth. Care should be taken to avoid creating conditions leading to rapid thick accumulations of dead aquatic plants to promote more complete decomposition of dead plant material.
- **Loss of native aquatic plants and related reduction or loss of desirable aquatic organisms.** EWM and other invasive plants often grow in complexly intermingled beds. Additionally, EWM is physically similar to, and hybridizes with, native milfoil species. Native plants, such as pondweeds, provide food and spawning habitat for fish and other wildlife. A robust and diverse native plant community forms the foundation of a healthy lake, and the conditions needed to provide and

⁶³ U.S. Environmental Protection Agency, EPA-738-F-05-002, 2,4-D RED Facts, June 2005.

⁶⁴ M.A. Ibrahim et al., “Weight of the Evidence on the Human Carcinogenicity of 2,4-D”, Environmental Health Perspectives 96: 213-222, December 1991.

⁶⁵ Though the manufacturers indicate that swimming in 2,4-D-treated lakes is allowable after 24 hours, it is possible that some swimmers may want more of a wait time to lessen chemical exposure. Consequently, allowing extra wait time is recommended to help lake residents and users can feel comfortable that they are not being unduly exposed to aquatic plant control chemicals.

⁶⁶ Historic water quality data do not regularly exceed nutrient thresholds that would be indicative of algal blooms. Visit the Wisconsin Water Explorer (WEx) to view chlorophyll-a and total phosphorus measurements collected in the Lakes.

⁶⁷ The WDNR’s water quality standard to support healthy fish communities is 5 mg/L for warmwater fish communities and 7 mg/L for coldwater fish communities.

host desirable gamefish. Fish, and the organisms fish eat, require aquatic plants for food, shelter, and oxygen. If native plants are lost due to insensitive herbicide application, fish and wildlife populations often suffer. For this reason, if chemical herbicides are applied to the Lake, these chemicals must target EWM or curly-leaf pondweed and therefore should be applied in early spring when native plants have not yet emerged. Early spring application has the additional advantage of being more effective due to colder water temperatures, a condition enhancing herbicidal effects and reducing the dosing needed for effective treatment. Early spring treatment also reduces human exposure concerns (e.g., swimming is not particularly popular in early spring).

- **Need for repeated treatments.** Chemical herbicides are not a one-time silver-bullet solution—instead, treatments need to be regularly repeated to maintain effectiveness. Treated plants are not actively removed from the Lake, a situation increasing the potential for viable seeds/fragments to remain after treatment, allowing target species resurgence in subsequent years. Additionally, leaving large expanses of lakebed devoid of plants (both native and invasive) creates a disturbed area without an established plant community. EWM thrives in disturbed areas. In summary, applying chemical herbicides to large areas can provide opportunities for exotic species reinfestation and new colonization which in turn necessitates repeated and potentially expanded herbicide applications.
- **Hybrid watermilfoil's resistance to chemical treatment.** The presence of hybrid watermilfoil complicates chemical treatment programs. Research suggests that certain hybrid strains may be more tolerant to commonly utilized aquatic herbicides such as 2,4-D and Endothall.^{68,69} Consequently, further research regarding hybrid watermilfoil treatment efficacy is required to apply appropriate herbicide doses. This increases the time needed to acquire permits and increases application program costs.
- **Effectiveness of small-scale chemical treatments.** Small-scale EWM treatments using 2,4-D have yielded highly variable results. A study completed in 2015 concluded that less than half of 98 treatment areas were effective or had more than a 50 percent EWM reduction.⁷⁰ For a treatment to be effective, a target herbicide concentration must be maintained for a prescribed exposure time. However, wind, wave, and other mixing actions can dissipate herbicide doses, which decrease their effectiveness in the target area and negatively impact non-target areas and species. Therefore, when deciding to implement small-scale chemical treatments, the variability in results and treatment cost of treatment should be examined and contrasted.

As the District does not presently utilize chemical applications as part of its aquatic plant management program, chemical measures are not recommended to be re-incorporated into the program. However, small-scale chemical applications have been utilized by riparian property owners for reduction in plant mass near their piers. These small-scale chemical treatments are required to obtain a permit from the DNR for application and must be enclosed in a barrier, such as limno-barriers, to prevent movement of the herbicide outside its permitted treatment area.

Water Level Manipulation Measures

Manipulating water levels can also be an effective method for controlling aquatic plant growth and restoring native aquatic plant species, particularly emergent species such as bulrush and wild rice.⁷¹ In Wisconsin, water level manipulation is considered to be most effective by using winter lake drawdowns, which expose

⁶⁸ L.M. Glomski and M.D. Netherland, "Response of Eurasian and Hybrid Watermilfoil to Low Use Rates and Extended Exposures of 2,4-D and Triclopyr," *Journal of Aquatic Plant Management* 48: 12-14, 2010.

⁶⁹ E.A. LaRue et al., "Hybrid Watermilfoil Lineages are More Invasive and Less Sensitive to a Commonly Used Herbicide than Their Exotic Parent (Eurasian Watermilfoil)," *Evolutionary Applications* 6: 462-471, 2013.

⁷⁰ M. Nault et al., "Control of Invasive Aquatic Plants on a Small Scale," *Lakeline* 35-39, 2015.

⁷¹ For detailed literature reviews on water level manipulation as an aquatic plant control measure, see C. Blanke, A. Mikulyuk, M. Nault, et al., *Strategic Analysis of Aquatic Plant Management in Wisconsin*, Wisconsin Department of Natural Resources, 167-171, 2019 as well as J.R. Carmignani and A.H. Roy, "Ecological Impacts of Winter Water Level Drawdowns on Lake Littoral Zones: A Review," *Aquatic Sciences* 79: 803-824, 2017.

lake sediment to freezing temperatures while avoiding conflict with summer recreational uses. One to two months of lake sediment exposure can damage or kill aquatic plant roots, seeds, and turions through freezing and/or desiccation. As large areas of lake sediment need to remain exposed for extended periods, water level manipulation is most cost effective in lakes with operable dam gates that can provide fine levels of control of water elevations within the lake. In lakes without dams, high capacity water pumping can be used to reduce lake levels at much greater cost.

While water level manipulation affects all aquatic plants within the drawdown zone, not all plants are equally susceptible to drawdown effects. Abundance of water lilies and milfoils (*Myriophyllum* spp.) can be greatly reduced by winter drawdowns while other species, such as duckweeds, may increase in abundance.⁷² Two studies from Price County, Wisconsin show reduced abundance of invasive EWM and curly-leaf pondweed and increased abundance of native plant species following winter drawdowns.^{73,74} Thus, drawdowns can be used to dramatically alter the composition of a lake's aquatic plant community. Many emergent species rely upon the natural fluctuations of water levels within a lake. Conducting summer and early fall drawdowns have effectively been used to stimulate the growth of desired emergent vegetation species, such as bulrush, bur-reeds, and wild rice, in the exposed lake sediments, which subsequently provide food and habitat for fish and wildlife. However, undesired emergent species, such as invasive cattails and phragmites, can also colonize exposed sediment, so measures should be taken to curtail their growth during a drawdown.⁷⁵

Water level manipulation can also have unintended impacts on water chemistry and lake fauna.^{76,77} Decreased water clarity and dissolved oxygen concentrations as well as increased nutrient concentrations and algal abundance have all been reported following lake drawdowns. Rapid drawdowns can leave lake macroinvertebrates and mussels stranded in exposed lake sediment, increasing their mortality, and subsequently reducing prey availability for fish and waterfowl. Similarly, drawdowns can disrupt the habitat and food sources of mammals, birds, and herptiles, particularly when nests are flooded as water levels are raised in the spring. Therefore, thoughtful consideration of drawdown timing, rates, and elevation, as well as the life history of aquatic plants and fauna within the lake is highly recommended. Mimicking the natural water level regime of the lake as closely as possible may be the best approach to achieve the desired drawdown effects and minimize unintended and detrimental consequences.

As discussed above, water level manipulation is a large-scale, permitted operation that can have major effects on lake ecology. Consequently, detailed information on the Lake's hydrology, including groundwater, should be compiled before undertaking such an operation. The WDNR would likely require and consider the following during review of the drawdown permit application:

- Existing lake bottom contours should be reevaluated (see Map 1.1) with any changes mapped to develop updated bathymetric information.
- Lake volume needs to be accurately determined for each foot of depth contour.
- Lake bottom acreage exposed during various intervals of the drawdown must be determined.
- Knowledge of the drawdown and refill times for the Lake would guide proper timing of drawdown to maximize effectiveness and minimize impacts to Lake users.
- A safe drawdown discharge rate would need to be calculated to prevent downstream flooding and erosion.

⁷² G.D. Cooke, "Lake Level Drawdown as a Macrophyte Control Technique," *Water Resources Bulletin* 16(2): 317-322, 1980.

⁷³ Onterra, LLC, Lac Sault Dore, Price County, Wisconsin: Comprehensive Management Plan, 2013.

⁷⁴ Onterra, LLC, Musser Lake Drawdown Monitoring Report, Price County, Wisconsin, 2016.

⁷⁵ Blanke et al., 2019, op. cit.

⁷⁶ Ibid.

⁷⁷ Cooke, op. cit.

- Effects on the lake drawdown on the structural integrity of outlet dams should be examined.
- A WDNR permit and staff supervision are required to draw down a lake. Additionally, lakeshore property owners need to be informed of the drawdown and permit conditions before the technique is implemented. Targeted invasive species populations should be monitored before and after the refill is completed to assess efficacy and guide future management.



MANAGEMENT RECOMMENDATIONS AND PLAN IMPLEMENTATION

3

Credit: Commission Staff

This Chapter summarizes the information and recommendations needed to manage aquatic plants in the Lauderdale Lakes, particularly the nonnative species of Eurasian watermilfoil (EWM), starry stonewort (SSW), curly-leaf pondweed (CLP), and spiny naiad. Accordingly, it presents a range of alternatives that could potentially be used, and provides specific recommendations related to each alternative. The measures discussed focus on those that can be implemented by the Lauderdale Lakes Lake Management District (District) in collaboration with the Wisconsin Department of Natural Resources (WDNR) and the Lakes' residents. The aquatic plant management recommendations contained in this chapter are limited to approaches that monitor and control nuisance level aquatic plant growth in the Lakes after the growth has already occurred.

The individual recommendations presented below, and which collectively constitute the recommended aquatic plant management plan, balance three major goals:

- Improving navigational access within the Lake
- Protecting the native aquatic plant community
- Controlling CLP, EWM, and SSW populations

Plan provisions also ensure that current recreational uses of the Lakes (e.g., swimming, boating, fishing) are maintained or promoted. The plan recommendations described below consider common, State-approved, aquatic plant management alternatives including manual, biological, physical, chemical, and mechanical measures.

3.1 RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN

The most effective plans to manage nuisance and invasive aquatic plant growth generally rely on a combination of methods and techniques as well as consideration of when and where these techniques should be applied. The following paragraphs briefly summarize the management techniques for the Lauderdale Lakes; Figures 3.1, 3.2, and 3.3 visually present the techniques.

1. **Mechanically harvest invasive and nuisance aquatic plants.** Mechanical harvesting should remain the primary means to manage invasive and nuisance aquatic plants on the Lauderdale Lakes. Harvesting must avoid, or must be substantially restricted, in certain areas of the Lakes. This includes areas of particular ecological value, areas that provide unique habitat, areas that are difficult to harvest due to lake morphology (e.g., excessively shallow water depth), and where boat access is not desired or necessary (e.g., marshland areas). Almost half of Middle Lake is a sensitive area, a situation restricting mechanical harvesting to lanes that protect sensitive areas yet allows riparian residents and boat launch users to access and navigate the Lakes, engage in a variety of water-related recreational pursuits, and access open water areas. In all cases on all three Lakes, care should be taken to avoid harvesting native aquatic plants – harvesting should focus on areas of profuse invasive plant growth.
2. **Manually remove nearshore invasive and nuisance plant growth.** Manual removal involves controlling aquatic plants by hand or using hand-held non-powered tools. Manual removal does not require a permit if riparian landowners remove only invasive plants without injuring native plants or remove nuisance native aquatic plants along 30 or less feet of shoreline (inclusive of dock, pier, and other lake access areas) and generally not more than 100 feet into the lake, provided that all the resulting plant material is removed from the Lake.⁷⁷ A permit is required if the District or other group engages with the work or if the work is done in or adjacent to a WDNR-designated sensitive area.⁷⁸ Prior to the manual removal season, educational campaigns should be promoted to better educate landowners about the benefits of aquatic plants in the Lake, the manual removal of aquatic plants, plant identification, proper disposal of plant material and the specifics about the actions they are allowed to legally take to “clean up” their shorelines.⁷⁹
3. **Consider acquiring small aquatic plant harvesters to address nuisance growth near private piers.** Small-scale aquatic plant management is used by private landowners to address nuisance plant growth in highly trafficked areas. In some of these instances, chemical treatment is the preferred aquatic plant control method. While this is a viable method for addressing the plant growth, chemical treatment can negatively impact sensitive non-target species and repeated use over time can lead to inherited genetic resistance to chemical treatment. Several manufacturers produce small aquatic plant harvesters that are relatively inexpensive and can maneuver in tight spaces to target nuisance plant growth in these areas. A benefit of aquatic plant harvesting is that the removal of aquatic plants from the Lake also reduces the phosphorus load within the Lake. Acquisition of this equipment may be partially funded through the WDNR Recreational Boating Facilities Grant Program.⁸⁰ Areas that may benefit from use of small-scale harvesting include near the Lauderdale Shores private boat launch in Green Lake, as well as near the piers of Baywood Estates on Mill Lake.
4. **Limit the use of chemical treatment within the Lakes.** Large-scale chemical treatment has not been part of the District’s aquatic plant management plan since transitioning to harvesting for aquatic plant population control. Given the relatively low extent of invasive species within the Lakes and significant coverage by sensitive native species, large-scale treatment is not recommended at this time. Individual property owners with frontage not abutting designated sensitive areas may pursue

⁷⁷ The manual removal area limitation for nearshore aquatic plants applies to shorelines where native plants are present. The removal area limitation does not apply to areas populated solely with non-native and/or invasive plants.

⁷⁸ Permits for this removal are necessary under Chapter NR 109, Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations of the Wisconsin Administrative Code, as the removal of aquatic plants is not being completed by an individual property owner along his or her property.

⁷⁹ Commission and WDNR staff could help review such documents developed for this purpose.

⁸⁰ More information about the program can be found at: dnr.wisconsin.gov/aid/RBF.html.

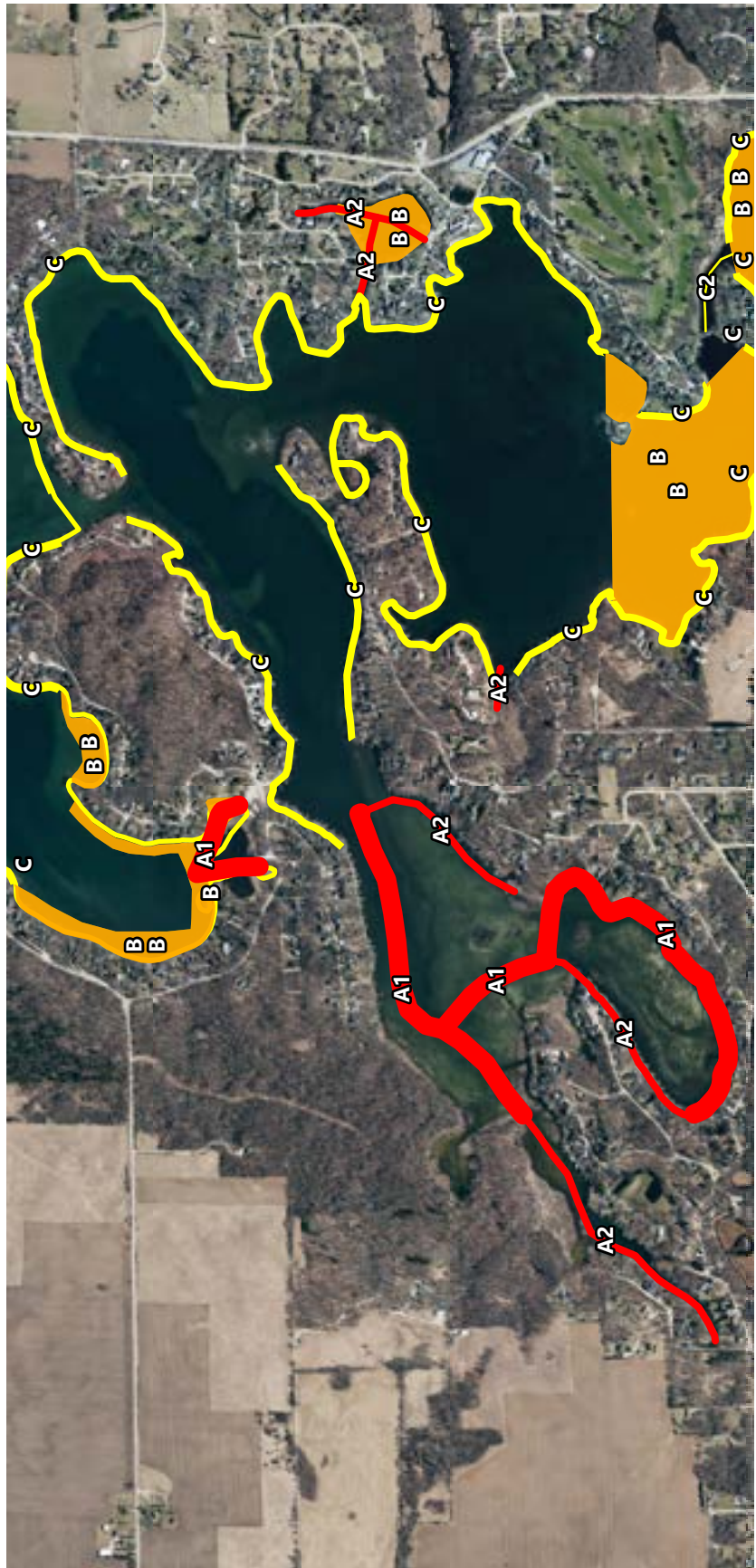
Figure 3.1
Recommended Harvesting Plan for Green Lake: 2025



Area	Instructions
HIGH PRIORITY AREAS	
A1	Cut a lane 50' wide to the 5' contour - Must leave 12" of plant growth on the bottom
A2	Cut a lane 15' wide to the 5' contour - Must leave 12" of plant growth on the bottom
MODERATE PRIORITY AREAS	
B	EWM Management Areas: Top cut to a depth of 4' to control surface matting of EWM growth and promote native species growth - Must leave 12" of plant growth on the bottom
LOW PRIORITY AREAS	
C	Surface cut only from pier heads to open water (variable widths) - Manual harvest ONLY from shore to pier heads

Source: Stantec, WDNR, and SEWRPC
Date of Photography: 2024

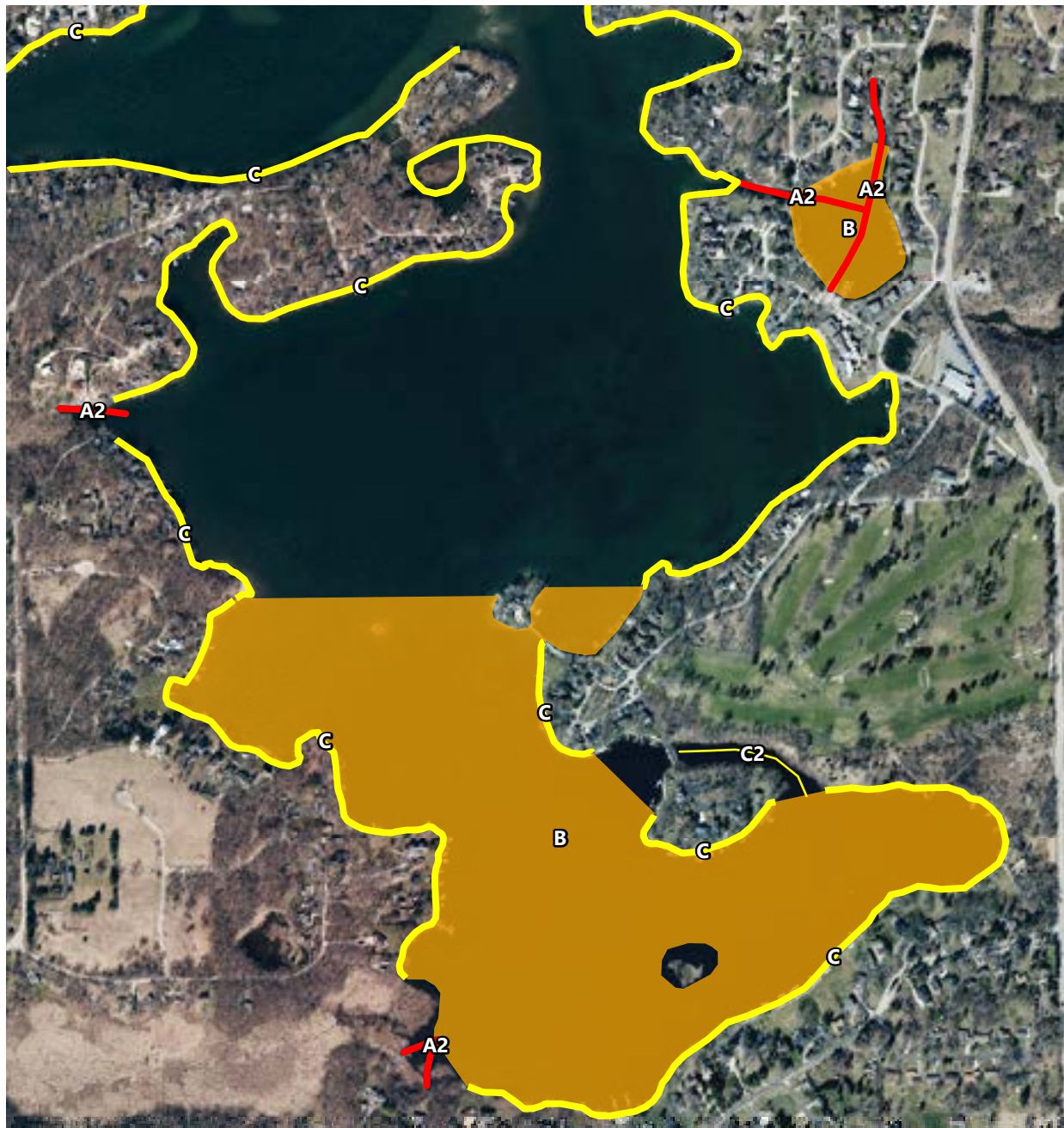
Figure 3.2
Recommended Harvesting Plan for Middle Lake: 2025



Area	Instructions
HIGH PRIORITY AREAS	
A1	Cut a lane 50' wide to the 5' contour - Must leave 12" of plant growth on the bottom
A2	Cut a lane 15' wide to the 5' contour - Must leave 12" of plant growth on the bottom
MODERATE PRIORITY AREAS	
B	EWM Management Areas: Top cut to a depth of 4' to control surface matting of EWM growth and promote native species growth - Must leave 12" of plant growth on the bottom
LOW PRIORITY AREAS	
C	Surface cut only from pier heads to open water (variable widths) - Manual harvest ONLY from shore to pier heads

Source: Stantec, WDNR, and SEWRPC
Date of Photography: 2024

Figure 3.3
Recommended Harvesting Plan for Mill Lake: 2025



Area	Instructions
HIGH PRIORITY AREAS	
A1	Cut a lane 50' wide to the 5' contour - Must leave 12" of plant growth on the bottom
A2	Cut a lane 15' wide to the 5' contour - Must leave 12" of plant growth on the bottom
MODERATE PRIORITY AREAS	
B	EWM Management Areas: Top cut to a depth of 4' to control surface matting of EWM growth and promote native species growth - Must leave 12" of plant growth on the bottom
LOW PRIORITY AREAS	
C	Surface cut only from pier heads to open water (variable widths) - Manual harvest ONLY from shore to pier heads
C2	15' to 20'-wide harvested channel for small non-motorized watercraft by a small harvester with shallow draft (up to 14" when basket is full)

Source: Stantec, WDNR, and SEWRPC
Date of Photography: 2024

a Chapter NR 107 permit to treat their shorelines. This method of aquatic plant control has several drawbacks (e.g., water quality, comparatively nonselective, chemical side effects, and more) and should only be considered under exceptional circumstances. When employed, a physical barrier (e.g., turbidity barrier) should be used to reduce chemical dispersal that could harm non-target species.

5. **Use DASH in high-use, congested, nearshore areas.** Riparian landowners could supplement or supplant manual harvesting or chemical controls by using DASH. If an individual landowner chooses to implement DASH, the activity is typically confined to the same area undergoing manual aquatic plant control – it is not a method to increase the amount of lakefront undergoing active management. DASH requires a Chapter NR 109 permit. DASH may also be suitable for controlling nuisance vegetation around private boat launches in lieu of chemical controls or small-scale mechanical harvesting.
6. **Continue monitoring for invasive species populations.** The District should conduct frequent monitoring near the boat launches and any other access points. Conducting pre- and post-treatment sub-point-intercept surveys should be ideal for evaluating the effects of any treatment on SSW, EWM, CLP, and non-target species. Conducting meander surveys or spot checks near the dam and public and private launches can allow more rapid detection and response before SSW can spread from these locations. These spot checks can be performed as part of the Citizen Lake Monitoring Network (CLMN) or Clean Boats, Clean Waters (CBCW) programs on a monthly basis in the summer, but at a minimum should be performed once a year. The District should share updates on its invasive species population monitoring with the WDNR and the Walworth County Aquatic Invasive Species (AIS) Coordinator.
7. **Continue participation in the Clean Boats, Clean Waters program** Participation in this program proactively encourages lake users to clean boats and equipment before launching and using them in the Lauderdale Lakes.⁸¹ Disbursement of informational handouts on topics such as watercraft inspection and invasive species identification can be utilized as a part of this program in addition to adding informational signage to public boat launch kiosks. Private launches should be educated through similar materials. Overall participation in CBCW will help lower the probability of invasive species entering and leaving the Lakes. The District has participated in the program since 2009.
8. **Provide signage, education, and outreach regarding starry stonewort.** Consider placing signage and conducting outreach with the Lakes' residents, users, and boat rental facilities regarding the presence of starry stonewort in the Lakes. The same educational materials should be provided regarding safety tips and practices all lake users in order to reduce the spread of invasive species. Owners of private launches should be educated on proper boating contamination as well as be educated on where to find and how to post appropriate signage at their launches. Signs and/or advisory buoys could be placed near the populations in each of the Lakes to warn boats to check their boats, anchors, and/or pets if they pass through in these areas.⁸² Collaboration with the WDNR Lakes Biologist, Walworth County AIS Coordinator, and/or other lakes with SSW can streamline access to informational and impactful resources to educate Lake users on the invasive species.
9. **Ensure accessible, accurate record-keeping of District activities through training, utilizing existing informational resources, and centralizing information.** Maintaining accessible report records within the District allows direct and standardized comparison of operations (i.e., harvesting, chemical treatments, and other lake management efforts) across time and may be used in guiding future management decisions. District members should be aware on what activities are being tracked, what information is essential for legal reporting, and agree on what other data could be useful for the District's own needs. It is important that these records are housed somewhere accessible to future board members (e.g., a shared cloud storage system), as board turnover can cause loss of information if kept by individuals only. Information can be shared at the District's annual meeting, hosted on the District website, or entered into the ePermitting System through the WDNR.⁸³

⁸¹ Further information about Clean Boats Clean Waters can be found on the WDNR website at: dnr.wi.gov/lakes/cbcw.

⁸² Any buoys carrying a requirement to slow, reverse prop, or avoid will need to have a local ordinance in place.

⁸³ dnr.wisconsin.gov/permits/water.

10. **Consider treating SSW near Westshore Drive boat launch using DASH.** The current best-management practices for starry stonewort support active management when the populations are causing navigational/recreational impairment due to tall growth in shallow waters or in areas with heavy boat traffic. These practices minimize the spread out of affected areas as a part of a containment strategy in light of not having other effective management options for this species in particular (i.e., full eradication is not feasible with current tools). In these situations, Diver-Assisted Suction Harvesting and/or Diver Assisted Hand Removal are recommended.⁸⁴ Presently, starry stonewort populations only meet these criteria near the Westshore Drive boat launch in Green Lake, though monitoring other populations is necessary and could warrant future management. These strategies would be appropriate for the other launches or high-traffic areas of the lakes should SSW make it to those spots. Treatment efforts were discussed with the District, and concluded with interest to begin as soon as the summer of 2026, though further scheduling is needed.⁸⁵
11. **Continue to protect WDNR-designated Sensitive Areas.** As a highly developed chain of Lakes, maintaining protection over the seven WDNR-designated Sensitive Areas, these resources can continue to offer biodiversity, unique ecosystem functions, and recreational opportunity. Impacts of development on Sensitive Areas over time can be seen in decreased populations of wild rice (*Zizania* sp.) in Sensitive Area 3, where the coverage was reported to be 50-75% of the Area in 2004, and then only seen for a stretch of shoreline in the eastern portion of the Sensitive Area in 2019.⁸⁶ The 2025 survey observed similar populations of wild rice to the 2019 survey, indicating a steep decline in population from 2004-2019. Enforcing ordinances that protect Sensitive Areas such as Slow, No-Wake Zones, limiting chemical treatments only for targeted non-native invasive species, and restricting mechanical harvesting to only navigational channels can help in the protection of these Areas (see Map 2.1).⁸⁷ During the 2025 survey, specific concerns relating to Sensitive Areas 5 and 7 were noted by residents and discussed with the WDNR. In Sensitive Area 5, navigation has been impaired for non-motorized watercraft due to dense aquatic plant growth. A 15- to 20-foot-wide channel would be permissible through the use of a smaller harvester with a shallow draft (up to 14 inches when basket is full). A permit would be conditioned to require a second observer when cutting this channel to collect fish, frogs and turtles on the conveyor belt and return them back into the lake. Issues with accumulated sediment Sensitive Area 7 reported sediment accumulation over time by the bridge, and could potentially be approved for a small-scale dredging project for the purposes of navigation if the water depth is less than two feet. Further consultation regarding permitting can be provided by the WDNR to ensure appropriate management is taken.

Harvesting Conditions

Figures 3.1, 3.2, and 3.3 illustrate the overall aquatic plant recommendations for the Lauderdale Lakes.⁸⁸ To assure sustainable recreational use and long-term health of the Lakes, the following conditions must be added to all aquatic plant harvesting practices.

1. **Maintain and operate harvesting equipment in conformance with manufacturer's recommendations.** For example, never operate the harvester in water shallower than the maximum draft range of the harvester (e.g., 20 inches for the ILH7-450 Aquatic Weed Harvester) and never operate with the cutter head or paddle wheels at or near the lake bottom.
2. **Inspect all cut plants for live animals.** Immediately return live animals to the water. When feasible, a second staff person equipped with a net could accompany and assist the harvester operator.

⁸⁴ Endorsed by WDNR Southeast Region AIS Biologist, Patrick Siwula in email correspondence with the District, WDNR Lakes Biologist, and SEWRPC in August of 2025.

⁸⁵ Meeting between WDNR, SEWRPC, and members of the Lauderdale Lakes Lake Management District on August 25th, 2025.

⁸⁶ apps.dnr.wi.gov/swims/Documents/DownloadDocument?id=10396429.

⁸⁷ As recommended in the WDNR, Lauderdale Lakes (Walworth County, Wisconsin) Integrated Sensitive Area Report.

⁸⁸ Line width and location are not scales and only illustrate overall concept. The actual size, orientation, and depth of plant management activities depend upon sensitive area restrictions and permit conditions and site-specific factors. Site-specific factors include the composition of the plant community, water depth, shoreline configuration and obstacles, amongst other factors.

Animals can be caught in the harvester and harvested plants, particularly when cutting larger plant mats. Consequently, carefully examine cut materials to avoid inadvertent harvest of fish, crustaceans, amphibians, turtles, and other animals.

3. **Harvesting should not occur in the early spring to avoid disturbing fish spawning.** Studies suggest that harvesting activities can significantly disturb the many fish species that spawn in early spring. Thus, avoiding harvesting during this time can benefit the Lake's fishery. Typical harvesting operations usually begin around memorial day but may vary due to harvesting staff availability, recreational usage of the Lake, and the density of aquatic plant growth.⁸⁹
4. **All harvester operators should adhere to the harvesting specifications and practices as described in the harvesting permit.** Harvester operators should review the aquatic plant management plan and associated permits, with special emphasis focused on the need to restrict cutting in shallow areas, possess plant identification skills to encourage preservation of native plant communities, and knowledge of the proposed cutting area acreage and actual volume harvested as required. These documents can be compiled as training materials to be discussed with operators prior to the start of the harvesting season. Documenting participation can ensure all conditions of the harvesting permit and essential information have been communicated with those executing it. Ensuring all employees are knowledgeable and consistent in efforts ensures long-term program success.
5. **Management, record keeping, monitoring, and evaluation.** District staff manage harvesting operations and are responsible for the overall plan execution and logistics. All daily harvesting activities will be documented in writing by the harvester operator in a permanent harvesting operations log. At a minimum, as required by the harvesting permit, harvested plant volumes must be reported to the WDNR at the end of the harvesting season. Other information of harvesting patterns, weed pickup, plant types, harvesting location, and other information will be recorded to streamline efficiency of harvesting operators and communication with residents.⁹⁰ Daily maintenance and service logs recording engine hours, fuel consumed, lubricants added, oil used, and general comments will be recorded for financial tracking and transparency with District funds. Furthermore, this log should include a section to note equipment performance problems, malfunctions, or anticipated service. Platforms such as Microsoft Excel or Google Sheets are commonly used for tracking the aforementioned activities for ease in calculations and observation of trends over time. While there is no one 'right' template, discussing with other lake groups and/or a WDNR lakes biologist can inform how other groups may be formatting their data collection. All data will streamline functionality in harvesting operations. Monitoring information will be summarized in an annual summary report prepared by the District, submitted to WDNR, and available to the public.
6. **Standardization of harvesting operations.** When defining the amount of harvested plant material from the Lake, estimations are typically made regarding the mass of plants harvested. As previously mentioned, accurate record keeping is essential for organization, but standardization of these estimations allows for continued accuracy. Standardization methods should define:
 - *What is a "load" of plants?* These loads can vary based on if the load is for a harvester or a truck.
 - *How are partial loads accounted for?* Partial loads can be rounded to the nearest quarter or half.
 - *What is the volume capacity of your equipment?* Knowing the capacity can help with estimations of harvested aquatic plant material carried.
 - *How is the weight of aquatic plants accounted for?* Different aquatic plant communities can have differing weights at the same volume due to their intrinsic density, or how tightly packed together they are when harvested. Periodically weighing a sample of harvested plants to ensure accuracy may be useful when making estimations.

⁸⁹ Harvesting in sensitive areas may not begin until June 30th.

⁹⁰ Volume is most often reported in cubic yards of harvested material.

7. **Harvesting can fragment plants and recreational boating can also fragment plants**, especially on the weekends. Plant fragments may float in the Lakes, accumulate on shorelines, and help spread undesirable plants. The harvesting program should include a comprehensive plant pickup program that all residents can use. This helps ensure that harvesting and recreational boating does not become a nuisance for Lake residents. The program typically includes residents raking plants, placing them in a convenient location accessible to the harvester (e.g., the end of a pier), and regularly scheduled pickup of cut plants by the harvester operators. This effort should be as collaborative as practical.
8. **Properly dispose of plant debris.** All plant debris collected from harvesting activities must be collected and disposed of at the designated disposal sites, as shown on Figure B.1 and B.2 in Appendix B. No aquatic plant material may be deposited within identified floodplain and wetland areas.

Future Funding

Current efforts pursued by the District have been effective at maintaining a healthy and diverse aquatic plant community while suppressing aquatic invasive species populations. The District should continue to utilize WDNR Surface Water Grants to further their efforts in monitoring the Lake, inspecting watercraft at boat launches, and targeting areas for management. Eligibility for these programs varies, and staying abreast of grants available through the Surface Waters Grant website can aid in guiding where to put grant writing and project proposal efforts.⁹¹ Additionally, submitting grant proposals by pre-application deadlines allows applicants to get feedback on grant proposals by the WDNR before final submission is due, and allows applicants time to make any edits for a stronger application. Key grant programs to fund these efforts are as follows:

- **Clean Boats, Clean Waters** – this grant program covers up to 75 percent of up to \$24,000 to conduct watercraft inspections, collect data, educate boaters about invasive species, and reporting invasive species to the WDNR.
- **Aquatic Invasive Species Prevention** – this grant program covers up to 75 percent of either \$4,000 or \$24,000 for projects that help prevent the spread of AIS species. Eligible costs include the acquisition of decontamination equipment at public boat launches as well as targeted management at boat launches or other access points. All lakes are eligible for at least \$4,000 in funding but lakes that are designated as high priorities for AIS spread statewide, due to large amounts of boat traffic and/or the presence of particular invasive species, are eligible for \$24,000. Due to the presence of the invasive starry stonewort (*Nitellopsis obtusa*), the Lauderdale Lakes are eligible for up to \$24,000 via this grant program. The District must continue to participate in the Clean Boats, Clean Waters program to maintain eligibility for this grant program.
- **Early Detection & Response** – these non-competitive grants are available for new findings of AIS and are accepted on a rolling application basis. The grant program covers up to 75 percent of \$25,000 total project costs. One grant can be available for pioneering populations of NR40 restricted species but new populations of NR40 prohibited species, such as SSW, are not beholden to the pioneering population requirements. As these projects occur outside the typical grant cycle and do not require a management plan, close coordination with WDNR staff to scope and carry out the project is required. Activities may include education, pathway prevention, and/or monitoring; control actions may be appropriate when they are likely to result in population removal or limitation of a population to a small size, and must be developed in coordination with WDNR staff.
- **Aquatic Invasive Species Control** – this grant program covers up to 75 percent of up to \$50,000 for small-scale projects and \$150,000 for large-scale projects that suppress or reduce an AIS population within a lake. Given the newfound population of SSW, a large-scale project should be considered to reduce the spread of the species. Aquatic Invasive Species Control grants fund projects that utilize integrated pest management and are designed to cause multi-season suppression of the target species. An approved aquatic plant management plan is a requirement to participate in this program and only approved recommendations from the plan are eligible projects for funding through this program.

⁹¹ The Surface Water Grant website can be found at: dnr.wisconsin.gov/aid/SurfaceWater.html.

- **Recreational Boating Facilities Grant Program**⁹² – this grant program covers up to 50% of \$250,000 for a recreational boating facility project. These projects can include aquatic plant harvesting equipment, rehabilitation of facilities, trash skimming equipment, improvement or repair of locks, construction projects such as ramps or dredging for safe water depths.

The District should consider applying for these grant programs whenever feasible to support the monitoring, communication, watercraft inspection, and targeted management recommended in this aquatic plant management plan.

3.2 SUMMARY AND CONCLUSIONS

As requested by the District, the Commission worked with the District to develop a scope of work and secure funding to provide information useful to short- and long-term lake management. The primary motivation for this effort was to gather information needed to renew the District's aquatic plant management permit. This report, which documents the findings and recommendations of the study, examines existing and anticipated conditions, potential aquatic plant management problems, and lake-use. Conformant with the study's intent, the plan includes recommended actions and management measures. Figures 3.1, 3.2, and 3.3 summarize and generally locate where aquatic plant management recommendations should be implemented.

Successfully implementing this plan will require vigilance, cooperation, and enthusiasm, not only from local management groups, but also from State and regional agencies, Walworth County, municipalities, and residents/users of the Lakes. The recommended measures help foster conditions sustaining and enhancing the natural beauty and ambience of the Lauderdale Lakes' ecosystems while promoting a wide array of water-based recreational activities suitable for the Lakes' intrinsic characteristics.

⁹² dnr.wisconsin.gov/aid/RBF.html.

APPENDICES

AQUATIC PLANT SPECIES DISTRIBUTION

APPENDIX A

Figure A.1
Muskgrass Rake Fullness in the Lauderdale Lakes: Summer 2025

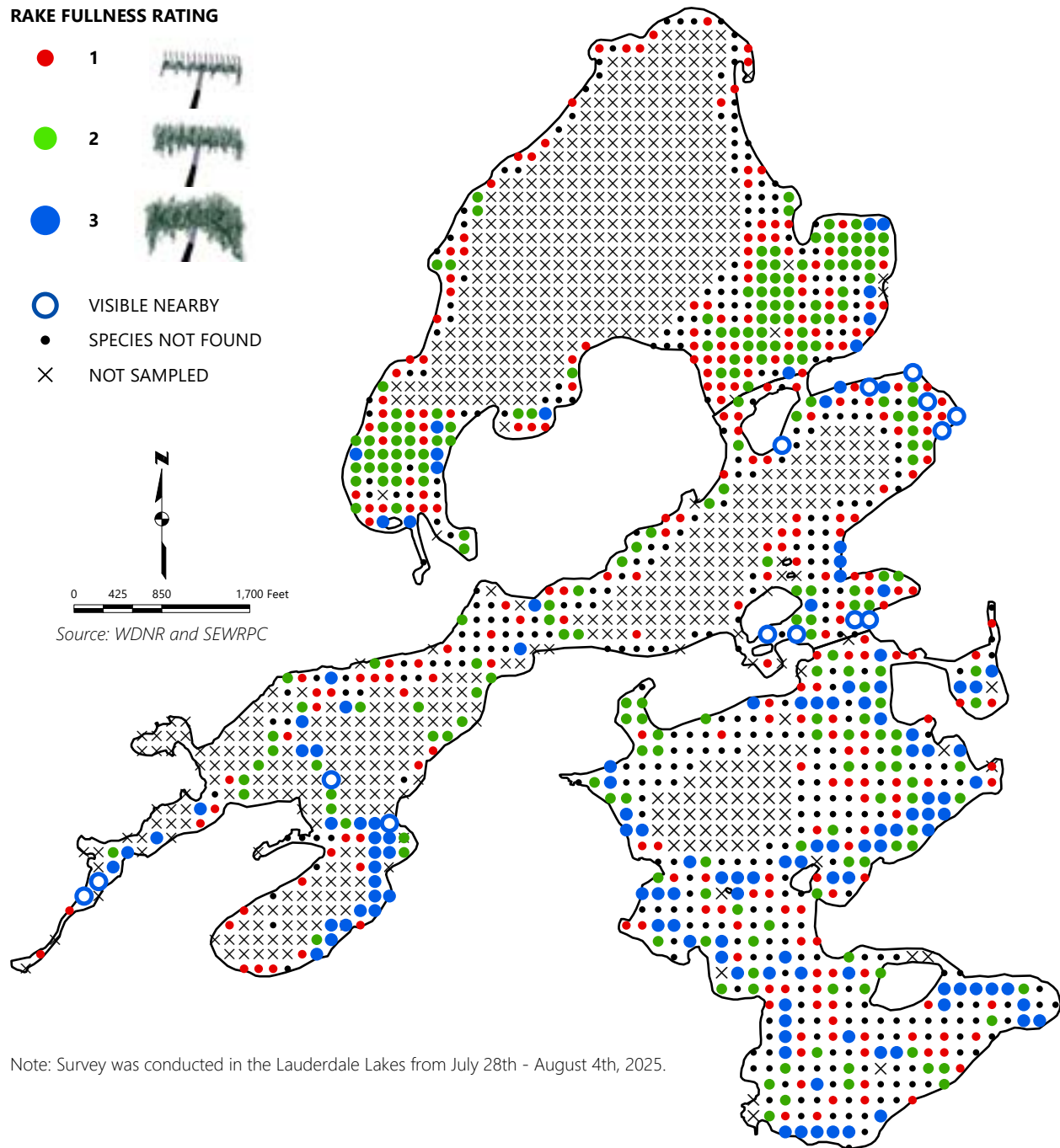


Figure A.2
Common Bladderwort Rake Fullness in the Lauderdale Lakes: Summer 2025

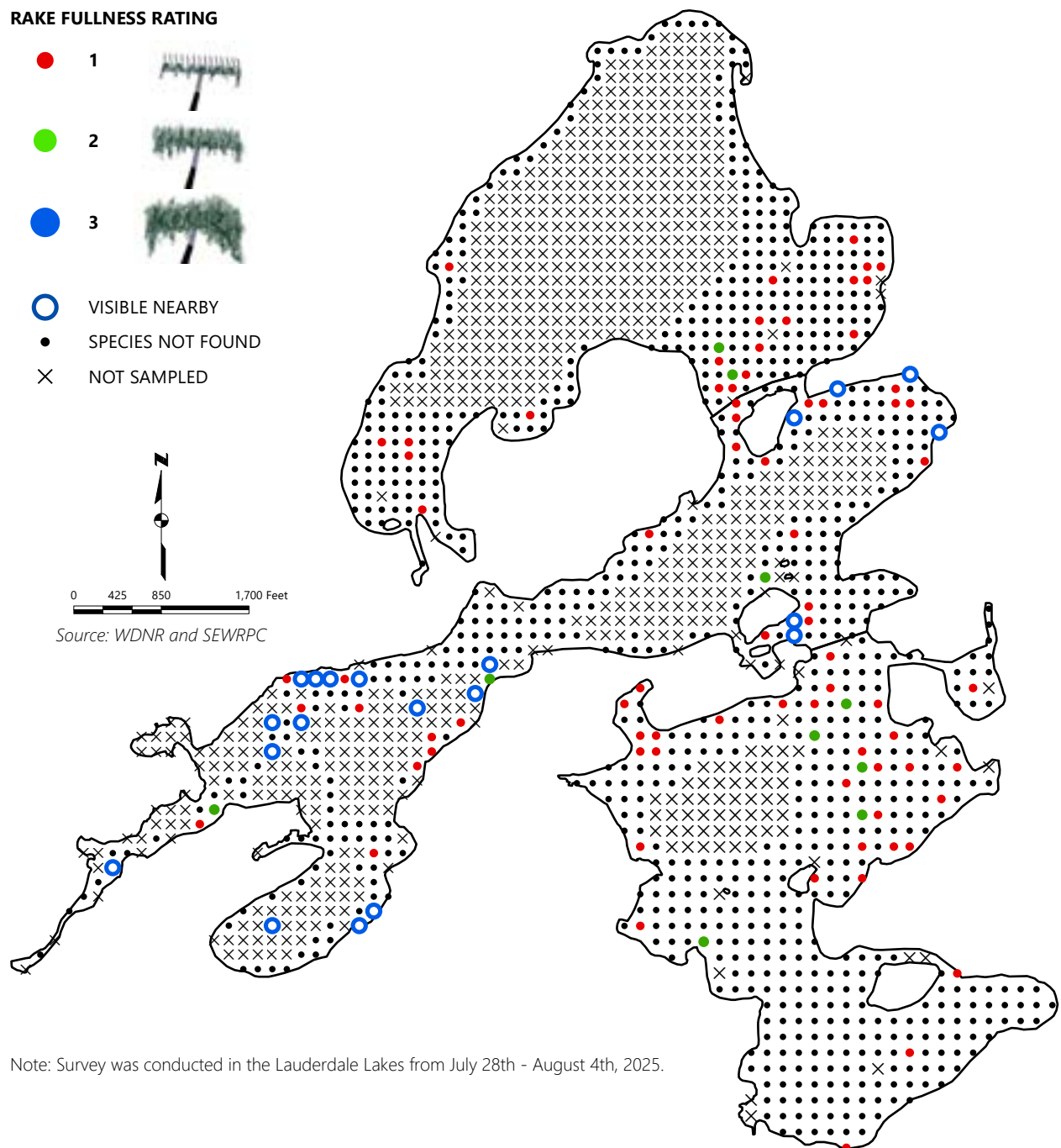


Figure A.3
Common Waterweed Rake Fullness in the Lauderdale Lakes: Summer 2025

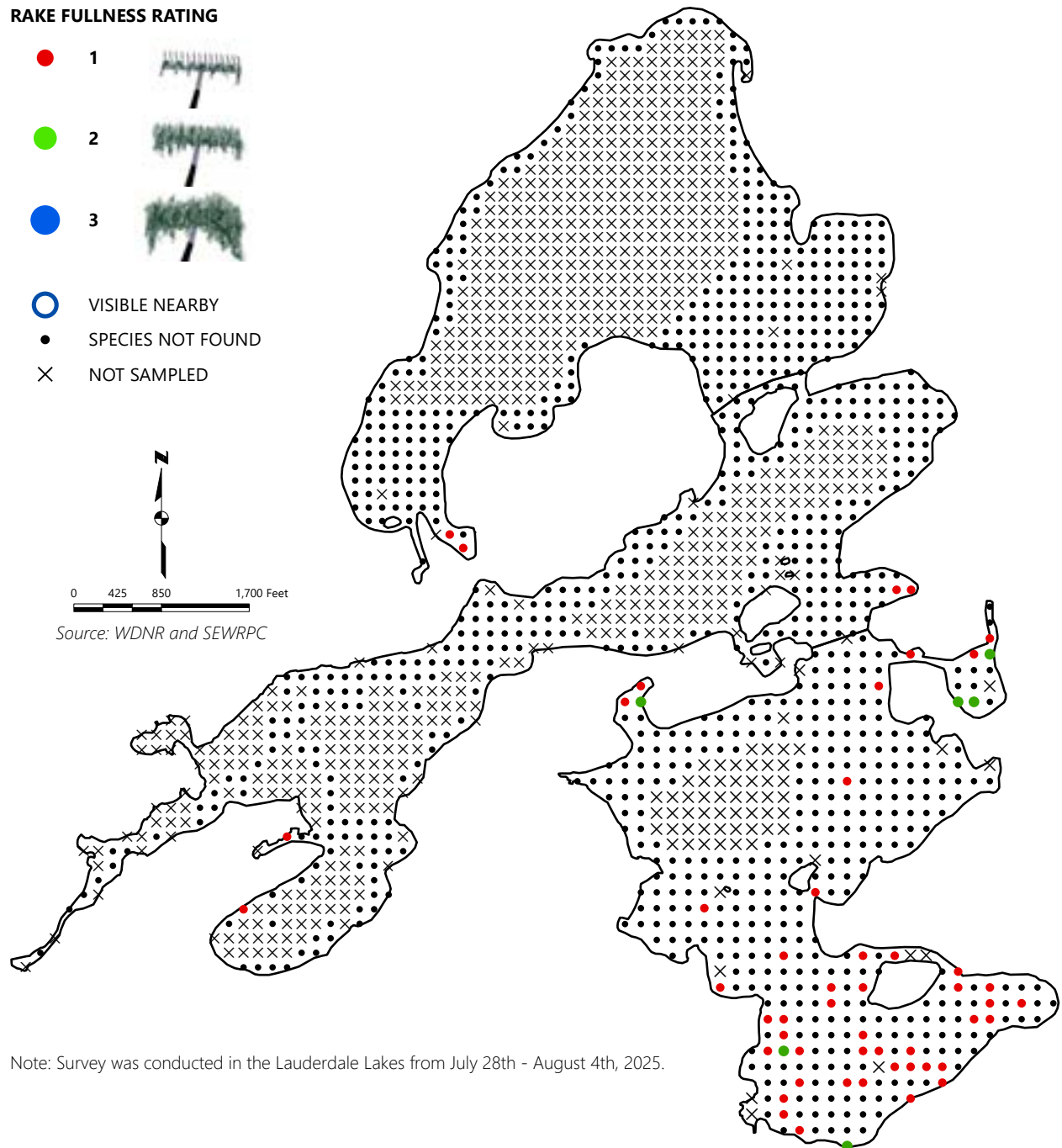


Figure A.4
Eelgrass Rake Fullness in the Lauderdale Lakes: Summer 2025

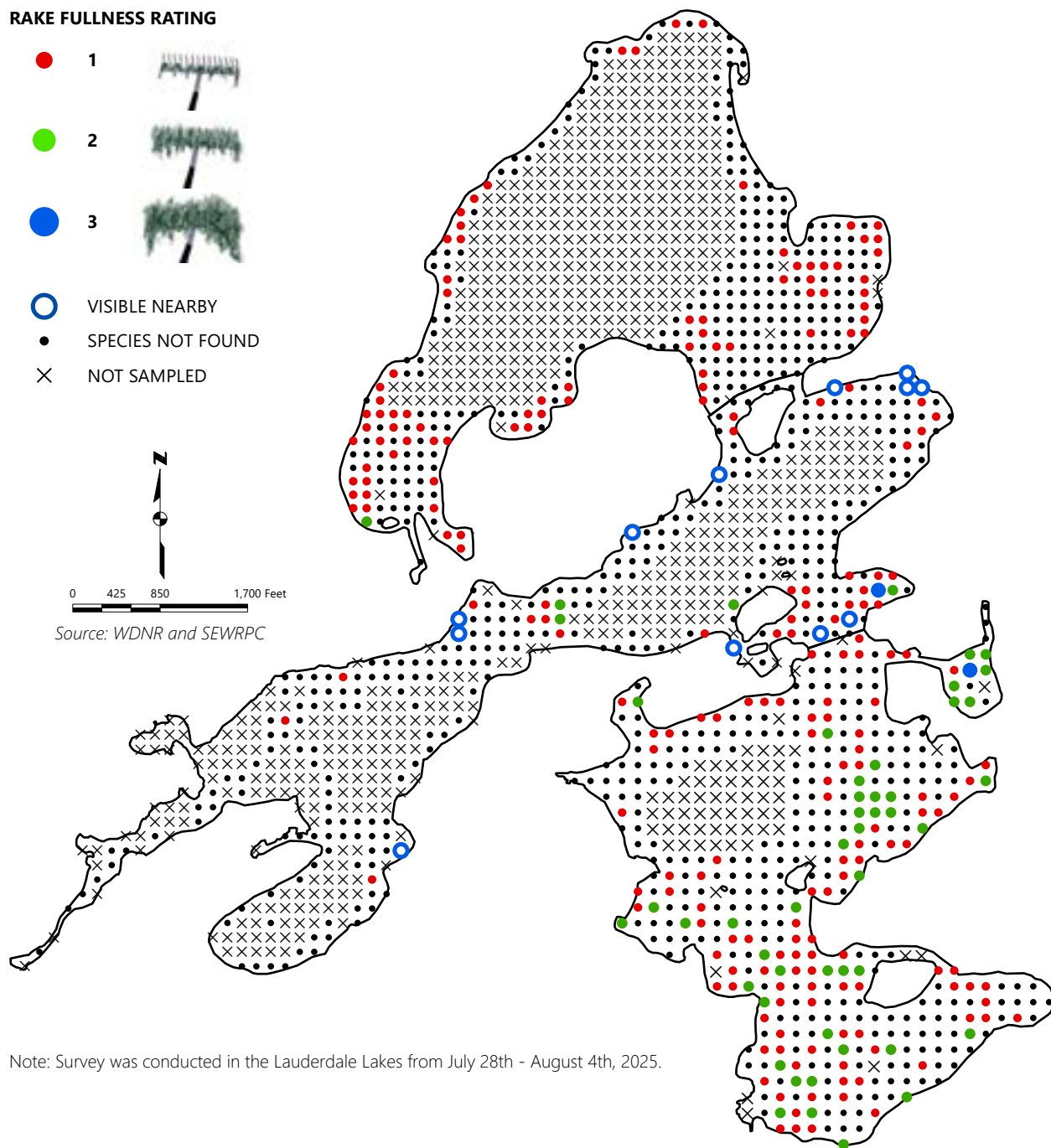
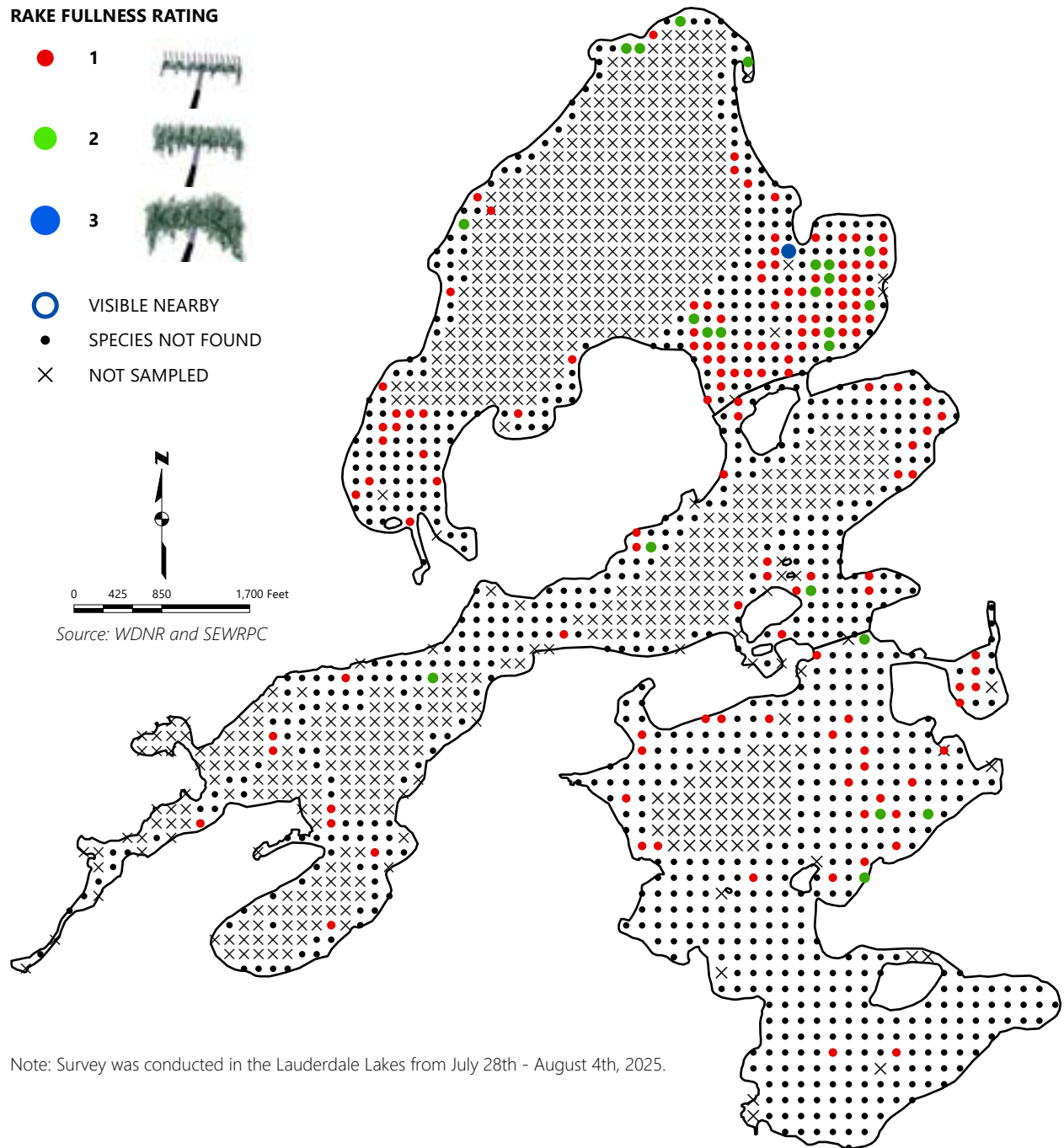


Figure A.5
Sago Pondweed Rake Fullness in the Lauderdale Lakes: Summer 2025



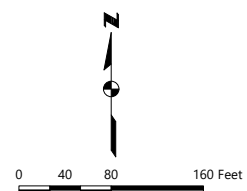
HARVESTING DISPOSAL SITES

APPENDIX B

Figure B.1
Harvesting Disposal Site: W. Territorial Road



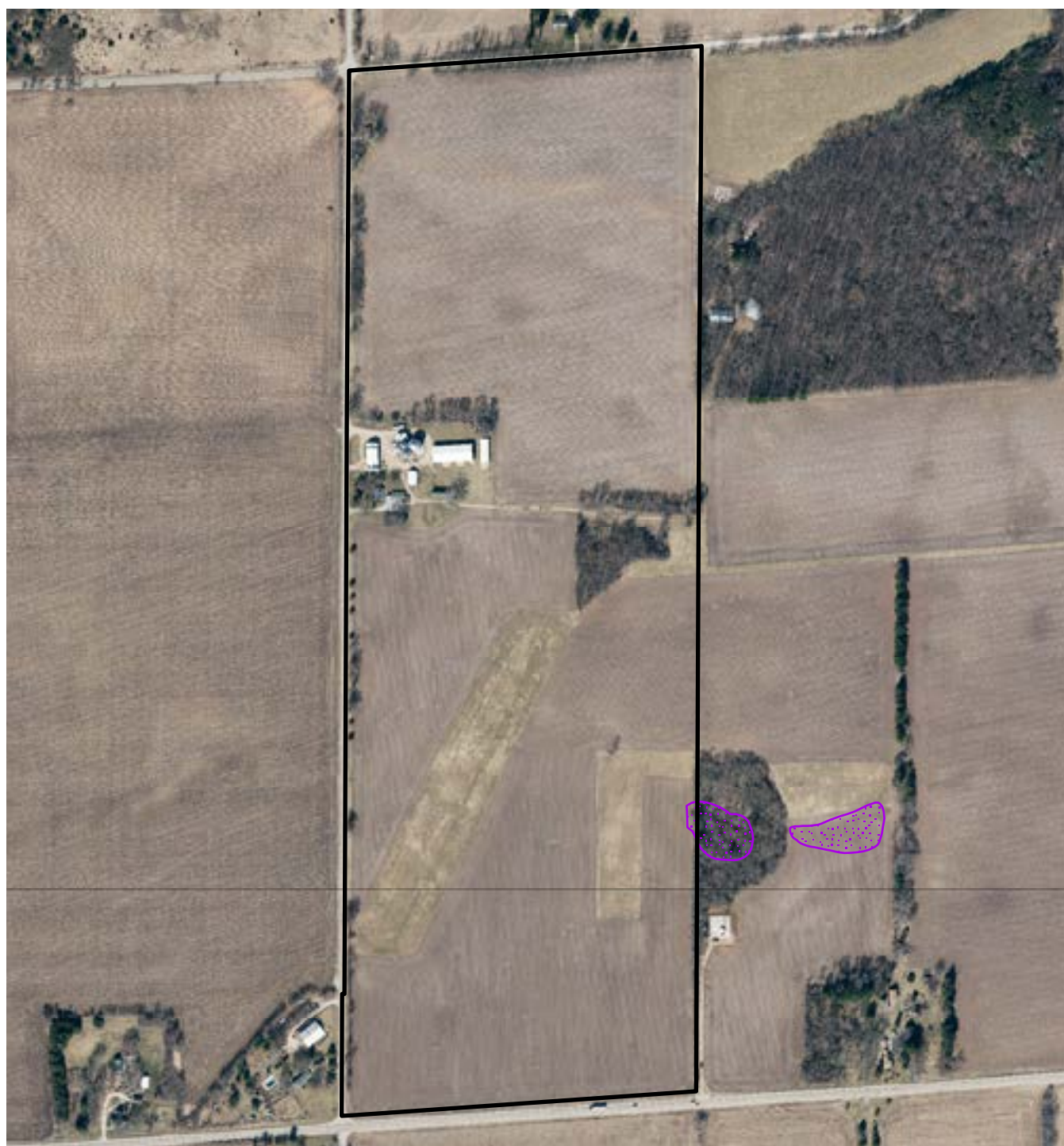
 Disposal Parcel



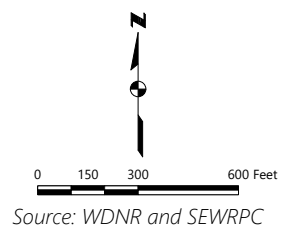
Note: No WDNR-Designated Wetlands are within the disposal site and map scale.

Source: WDNR and SEWRPC

Figure B.2
Harvested Plant Material Disposal Site: N. Tamarack Road



-  Disposal Parcel
-  WDNR- Designated Wetland



LAKE GLOSSARY OF TERMS

APPENDIX C

A

Alkalinity	The capacity of water to buffer against acidity, having a pH greater than 7
Anoxic	Without oxygen
Aquifer	Unconsolidated, porous and/or fractured bedrock units that can supply water over prolonged periods of time

B

Benthic	Pertaining to the bottom of waterbodies
Biocontrol	Biological control; use of animals, fungi, or diseases to control invasive populations. Referred to as 'control organisms', the chosen measure usually comes from the native range of the targeted invasive. The chosen control organisms require studies to ensure they will remain specific to the target population and will not harm native species
Biodiversity	Biological diversity; a measure of the variety of kinds of organisms present in an ecosystem
Biomass	The total quantity of plants and animals in a lake. Measured as organisms or dry matter per cubic meter, biomass indicates the degree of a lake system's eutrophication or productivity

C

C values	Coefficient of conservation values; numerical scores on a scale of zero to ten that reflect the likelihood that each species occurs in undisturbed habitat. These individual values are combined, then averaged in the calculation of a lake's FQI score
Chloride	A water-soluble ion (Cl-) that carries a negative charge and can be found in all water systems. High concentrations of this ion in water systems can have impacts on the biological integrity of the ecosystem. Often the addition of chloride into systems can be attributed to human activities
Chlorophyll	The major pigment involved in photosynthesis. The concentration of chlorophyll in a water sample is commonly used as an estimate of algal biomass
Clarity	The transparency of water, influenced by the amount of suspended particles (e.g. algae, sediment, tannins) in the water. Higher water clarity allows deeper light penetration into waterbodies and is important for aquatic life. Water clarity is often monitored by a Secchi disk
Cultural eutrophication	The process by which human activity accelerates the natural aging and eutrophication of lakes

D

DASH	Diver-Assisted Suction Harvesting. A mechanical aquatic plant removal method. Divers identify and pull selected aquatic plants from the lakebed and insert the entire plant in a suction hose that transports it to the surface for collection and further disposal. This removal method can be employed by individuals or groups, though it requires a NR 109 permit
Deep headwater lake	A hydrological classification of a lake. Lakes within this classification stratify as well as have less than 4 square miles of direct watershed drainage
Deep lowland lake	A hydrological classification of a lake. Lakes within this classification stratify as well as have 4 square miles or more of direct watershed drainage
Drainage lake	a hydrological classification of a lake. Lakes within this classification have both an inlet and outlet, usually fed from stream drainage
Drainage basin	The total land area that drains toward the lake

E

<i>E. coli</i>	A bacterium commonly found in waterbodies. <i>E. coli</i> is often monitored at beaches, as all warm-blooded animals have the bacteria in their feces; therefore, high amounts of <i>E. coli</i> suggest a high chance of fecal contamination in the water
Emergent plants	Aquatic vegetation that is rooted to the bottom but has leaves that float on the surface or protrude above the water
Epilimnion	The stratum of warm, mixed water above the thermocline in stratified lakes
Erosion	The processes that loosen and move particles from one place to another
Eutrophic	Nutrient-rich, high-productivity lakes. These systems are typically shallow and support high amounts of aquatic plant growth

F

Filamentous algae	Algae that forms filaments or mats attached to sediment, weeds, piers, etc
FQI	Floristic quality index. The average C value of all plant species identified in the lake, divided by the square root of species richness
Frequency of occurrence	Expressed as a percent, the percentage of times a species occurred when there was aquatic vegetation present at the sampling site

H

Herbicide	A pesticide designed to kill or control plants
Hypolimnion	The cold, deep layer in stratified lakes

I

Impoundment	A hydrological classification of a lake. Lakes within these classifications are human-made bodies of water and are usually classified as such if more than one-half of its maximum depth results from a dam or other type of control structure
Invasive species	Plants, animals, or pathogens that have been introduced to a location where it does not occur naturally, and is then capable of reproduction and widespread establishment in the new location if no human intervention is taken

L

Lake ecosystem	The interaction between living organisms and their nonliving environment
Littoral zone	The shallow, nearshore area of a lake or pond characterized by light penetration to the bottom

M

Macrophytes	Refers to higher (multi-celled) plants growing in or near water. Macrophytes are beneficial to lakes because they produce oxygen and provide substrate for fish habitat and aquatic insects. Overabundance of such plants, especially problem species, is related to shallow water depth and high nutrient levels
Maximum depth of colonization	The deepest point of a waterbody at which vascular aquatic plants can grow
Mechanical harvesting	An aquatic plant removal method in which specialized equipment, called 'harvesters,' cut and subsequently remove aquatic plants at specified depths
Mesotrophic	An aquatic system that's nutrient levels are between eutrophic (nutrient-rich) and oligotrophic (nutrient-poor) conditions
Metalimnion	The stratum between the epilimnion and hypolimnion exhibiting the marked thermal change; synonymous to thermocline

N

Natural resources	Structures and processes that can be used by humans but cannot be created by them
Nonnative species	Organisms that did not naturally occur in the region and were instead introduced. Nonnative species are not inherently invasive species
Nonpoint source	Diffuse pollutants, such as agricultural runoff, road salt, and acid rain, that are not from a single, confined source

O

Oligotrophic	Nutrient-poor, low productivity aquatic systems. These lakes are typically clear, have little aquatic plant growth, with sufficient dissolved oxygen near the bottom to support cold-water fish like cisco or trout.
Ordinary high watermark	Generally represented by a physical mark on the shoreline that stays consistent over time. These physical marks show above average water levels that still occur regularly enough to maintain the mark. These physical marks can be bank impressions, lack of vegetation, and/or soil differences

P

Phosphorus	A common nutrient found in fertilizers, organic wastes, and industrial effluent. In excess, it can speed up the eutrophication of aquatic systems, leading to algal blooms
Pollution	Any substance or material that degrades the environment for humans or other organisms widespread establishment in the new location if no human intervention is taken

R

Relative species abundance	Shown as a percentage, the proportion of a species to the total number of species in a given environment
Reservoir	Can reference a formation that acts as storage for fluids, such as groundwater or a hydrological classification of a waterbody type, interchangeably used with 'impoundment', where the waterbody is largely maintained through a dam
Riparian	Adjacent to waterbodies

S

Secchi disk	A black and white circular disk that measures the clarity of waterbodies. Secchi disks are lowered into the water until the disk is no longer visible. This depth is referred to as the 'secchi depth/reading'
Sedimentation	Accumulated organic and inorganic matter on the lake bottom. Sediment includes decaying algae and weeds, marl, and soil and organic matter eroded from the lake's watershed
Seepage lakes	Lakes without a significant inlet or outlet, fed by rainfall and groundwater. Seepage lakes lose water through evaporation and groundwater moving on a down gradient
Sensitive species	Organisms that are vulnerable to ecological disturbance, and thusly more likely to be found in less developed or disturbed areas
Shallow lowland lake	A hydrological classification of a waterbody. This lake type is naturally occurring, does not thermally stratify, and contains both an inlet and outlet
Shoreline	The physical point or general area of where a large waterbody meets the land
Species richness	A count of the total number of unique species found in an area of interest
Substrate	The substance found at the bottom of aquatic environments. In lakes, these are most commonly muck, sand, gravel
Stratification	The development of distinct layers in an ecological system. Examples of stratification can include temperature (epilimnion, metalimnion, and hypolimnion) and community types (canopy, shrub, and ground layer)

T

Thermocline	The region of the greatest vertical temperature change in a stratified waterbody
Two-story lake	Referring to a thermally stratified lake with distinct temperature and density differences. These lakes must often be large and deep enough to prevent entire mixing of the water column

W

Wakesports	A type of recreational watersport in which specifically designed motorboats, called wakeboats, create high waves to surf or board on. Wakeboats achieve large wakes through hull shapes, hydrofoil devices, and/or built-in-ballast tanks to displace more water
WDNR sensitive areas	Designated by the DNR, these areas of waterbodies help trap sediment and nutrients while providing habitat and food for fish, waterfowl, and other aquatic life. Areas under this designation have specific rules and regulations for possible aquatic plant management and recreational opportunities.
Watershed	An area of which its water runoff flows to a specified waterbody
Wetland	A land type classification, characterized by the presence of plants adapted to wet conditions and water-saturated soils

Z

Zooplankton	Microscopic or barely visible animals that eat algae. These suspended plankton are an important component of the lake food chain and ecosystem. For many fish, they are the primary source of food
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